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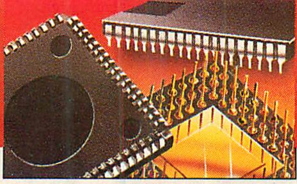

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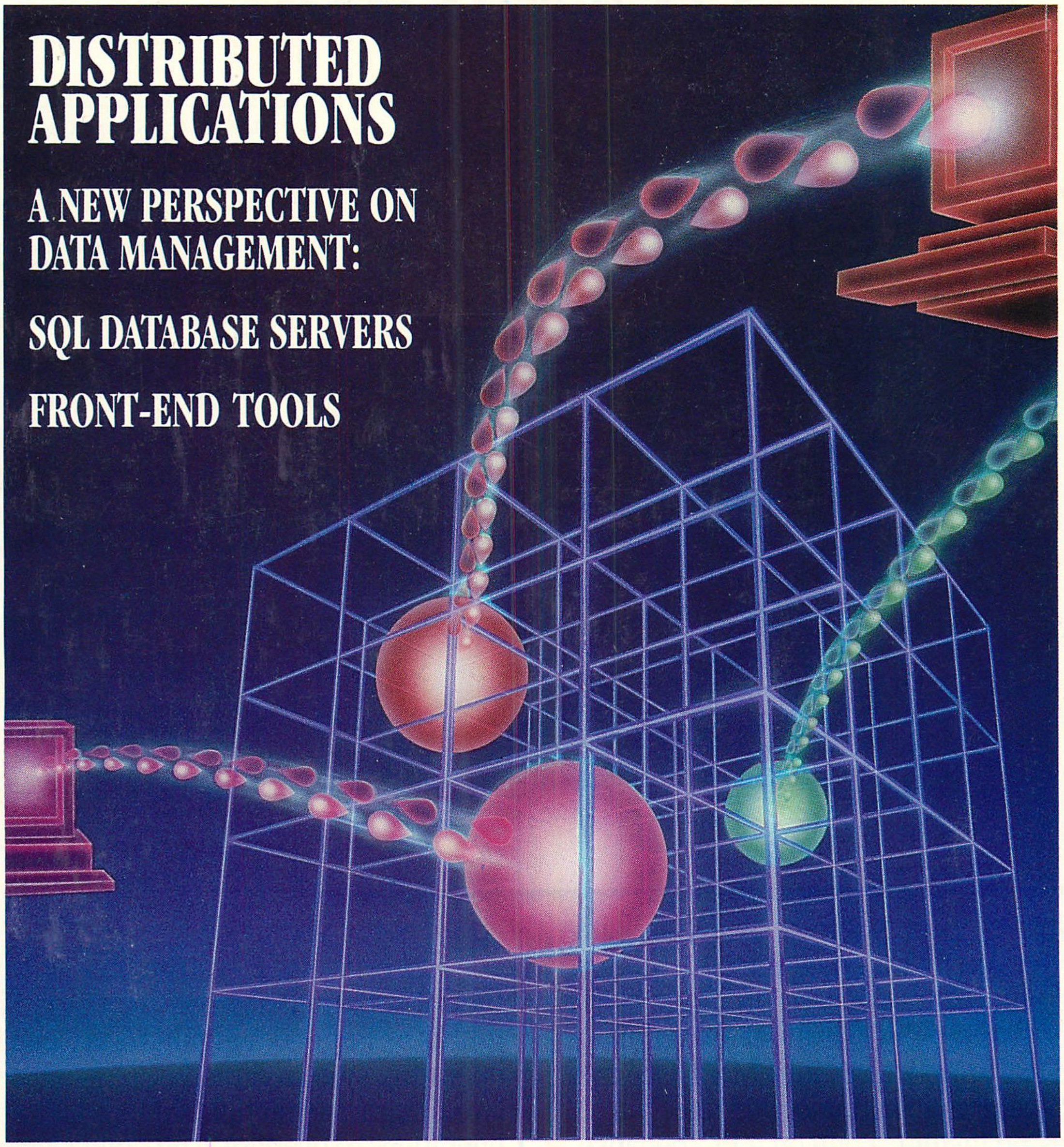

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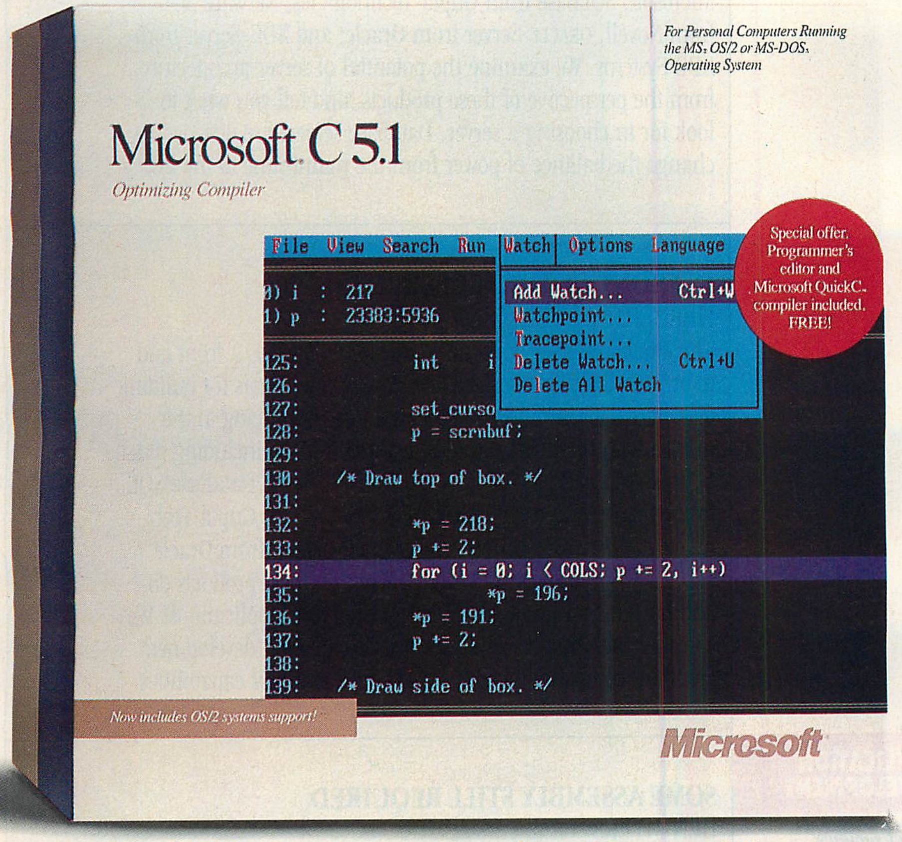

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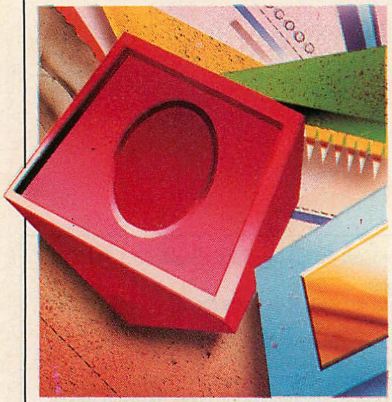

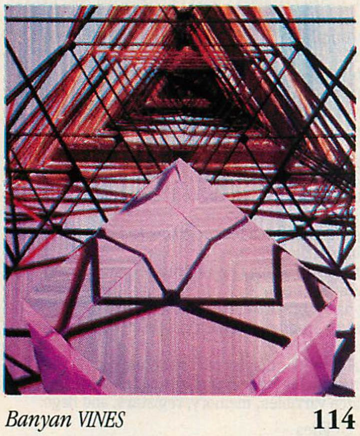

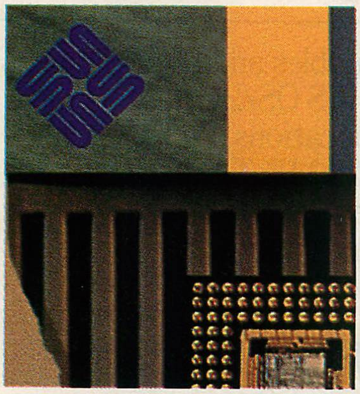

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VOLUME 7, NUMBER 3

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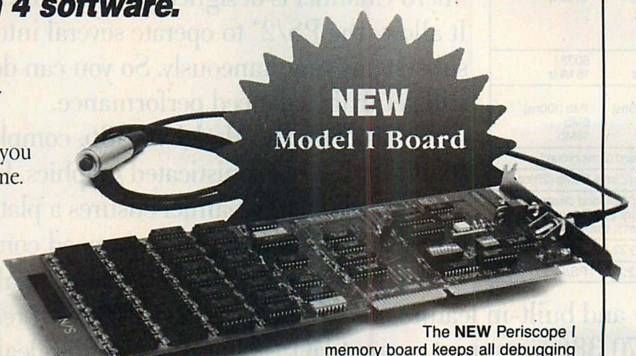
You No Longer Have to Share the Lower 640K With Your Debugger

Periscope I's new board uses ZERO memory in the lower 640K. Yet it has plenty of room to safely store all debugging information, like symbols, as well as the powerful Version 4 software.

Periscope's hardware adds the power to solve the really tough debugging problems.

The break-out switch lets you break into the system any time. You can track down a bug instantly, or just check what's going on, without having to reboot or power down and back up. That's really useful when your system hangs! The switch is included with Periscope I, Periscope II, and Periscope III.

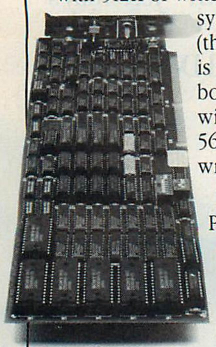


The **NEW** Periscope I memory board keeps all debugging information out of the lower 640K. Can be used in PCs, ATs, and 386s with both EGA/VGA and EMS boards installed. The Periscope break-out switch enables you to recover from a hung system. Included with Models I, II, and III.

Periscope I has a **NEW** board with 512K of write-protected RAM, user-expandable to 1MB, for the Periscope software, symbol tables, and all related debugging information. Normal DOS memory (the lower 640K) is thus totally freed up for your application, and Periscope is protected from being overwritten by a run-away program. The new board's footprint is only 32K, so you can use it in PC, AT, and 386 systems with EGA/VGA and EMS boards installed (not possible with the previous 56K board). It can also be used with Periscope III to provide additional write-protected memory.

Periscope III has a board with 64K of write-protected RAM to store the Periscope software and as much additional information as will fit. AND...

The Periscope III board adds another powerful dimension to your debugging. Its hardware breakpoints and real-time trace buffer let you track down bugs that a software-oriented debugger would take too long to find, or can't find at all!



The Periscope III hardware-breakpoint board captures information in real-time, so you'll find bugs that can't be found with a software-based debugger.

Periscope's software is solid, comprehensive, and flexible.

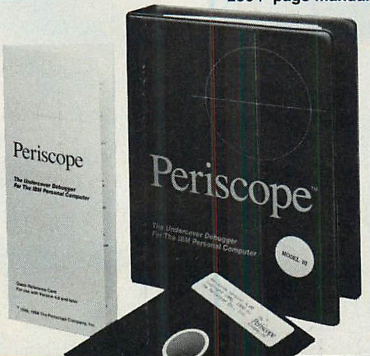
It helps you debug just about any kind of program you can write . . . thoroughly and efficiently.

Periscope's the answer for debugging device-drivers, memory-resident, non-DOS, and interrupt-driven programs. Periscope works with any language, and provides source and/or symbol support for programs written in high-level languages and assembler.

David Nanian, President of Underware, Inc. (of BRIEF fame) says this about the new Periscope Version 4:

"Periscope has always been an unbelievable assembler-level debugger. Version 4 has turned it into a terrific source-level debugger as well. Aside from major enhancements like the source-level improvements, all the little changes make a really big difference, too. For instance, symbol lookups and disassemblies are noticeably faster, and highlighting the registers that have changed really makes life easier. Once again, Periscope industry standard for debugg

Periscope software & 250+ page manual



What's New in Periscope Version 4:

- View local symbols from Microsoft C (Version 5)
- Debug Microsoft windows applications
- Set breakpoints in PLINK overlays
- Improved source-level support
- Monitor variables in a Watch window
- 80386 debug register support
- Debug using a dumb terminal
- PS/2 watchdog timer support
- Use mixed-case symbols
- Set breakpoints on values of Flags
- Much more!

■ **Periscope I** includes a **NEW** full-length board with 512K of write-protected RAM; (user-expandable to 1MB); break-out switch; software and manual for $795.

■ **Periscope II** includes break-out switch; software and manual for $175.

■ **Periscope II-X** includes software and manual (no hardware) for $145.

■ **Periscope III** includes a full-length board with 64K of write-protected RAM, hardware breakpoints and real-time trace buffer; break-out switch; software and manual. Periscope III for machines running up to 10 MHz with one wait-state is $1395. Plus the new Model I board, $1995.

Due to the volatility of RAM costs, prices on board models are subject to change without notice.

REQUIREMENTS: IBM PC, XT, AT, PS/2, 80386 or close compatible (Periscope III requires hardware as well as software compatibility, thus will not work on PS/2 or 80386 systems); DOS 2.0 or later; 64K available memory (128K at installation time); one disk drive; an 80-column monitor.

Call us with your questions. We'll be happy to send you free information or help you decide on the model that best fits your needs.

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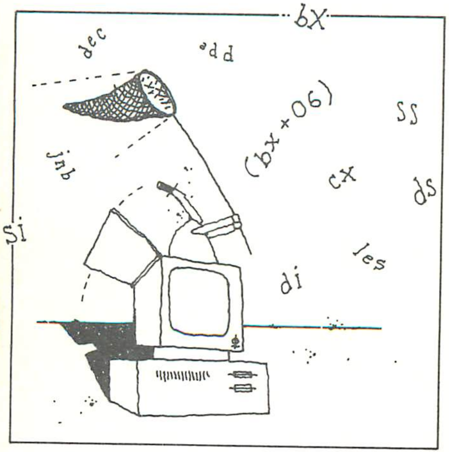
Professional Viewpoint



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SYSTEMS PERSPECTIVE

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Data Mismanagement

Data management got out of hand when end users developed their own applications. SQL server technology promises to regain control.

Until now, we've done PC-based data management all wrong. We handed data-management packages to end users and let them loose to develop their own applications. In the face of a massive backlog of corporate applications, we overlooked one very important fact: untrained end users do not understand basic database design techniques—normalizing data, defining relations, and choosing strategic fields to index.

After all, these end users were developing simple personal applications—client tracking systems or mailing lists. If the data were incorrectly entered, or if the application was inefficient, only the end user suffered.

Eventually, however, the end user's personal application grew into a work-group application. Colleagues needed access to the client data. The names on the mailing list grew into a corporate asset. Systems integrators moved the data files onto the work-group's LAN server and gave each end user a copy of the network version of the data manager. Still, everyone continued to disregard the end users' inability to handle security, integrity, and consistency. Most end users don't even know they have to consider those issues.

The systems developers and integrators who ignored these problems cannot be faulted. The technology was deficient. The data files residing on the server had no protective shell or intelligent application to guard the data; all responsibility for integrity checks resided in easily corruptible applications on DOS. Systems developers and integrators knew how fragile the data residing on a server were. Thus, they did not release their most critical business data to a LAN server.

Fortunately, the situation is changing. The latest developments in data management and LAN operating-system technology allow us to move more business data safely onto a LAN server.

An effective process-to-process communications protocol supported by the LAN server permits a data-management application to be distributed into server and front-end components that communicate using Structured Query Language (SQL). In this new architecture, the server application forms a protective wall around the data, ensuring its security, integrity, and consistency; and the front end allows the end user to create queries and request manipulation of the data.

Ideally, data security and integrity control is wrested away from the application and deposited back into the hands of the database administrator. In reality, however, with the first round of servers, the front end may still need to make preliminary integrity checks, but ultimately, the server holds the responsibility for the data.

The benefit to all is that developers now have the tools to build LAN-based, transaction-oriented production applications, while end users can write simple applications for decision support. They can query the data at will and personalize report formats without jeopardizing the data.

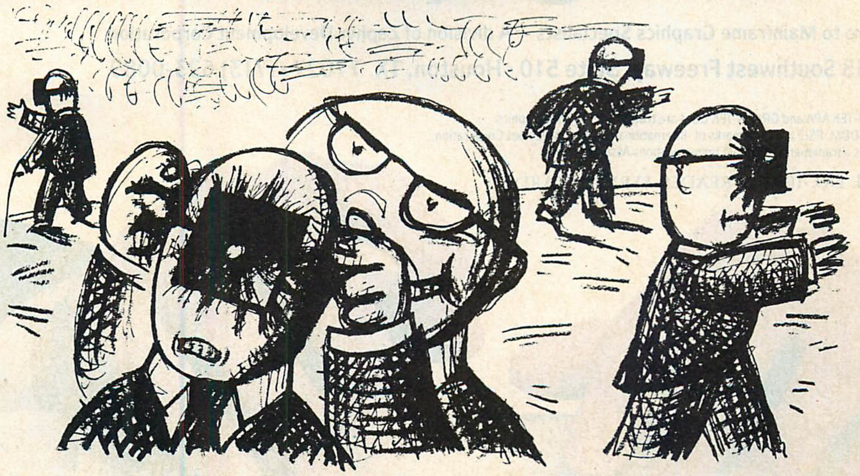
The new architecture also opens up opportunities for applications other than traditional data-management systems to become front ends. Spreadsheets, for example, may be able to access work-group data directly.

This month's cover suite on distributed applications explores the burgeoning technology of servers and front ends. Richard Finkelstein defines the issues involved in choosing a server in "The Database Server Odyssey" (p. 42). He compares the philosophies and features of servers from Ashton-Tate/Microsoft, Gupta Technologies, Novell, Oracle, and XDB Systems.

Herb Edelstein then surveys seven front ends in "In Front of the Server" (p. 62). Each of the server manufacturers has either promised or released a front-end product. In addition, Borland's Paradox and DataEase International's DataEase will act as independent front ends supporting a variety of servers. Edelstein focuses on what a front end can and should do, and which front end is best for which target audience.

DIRECTORY DIES, DATA LIVE

For two years, we produced the *PC Tech Journal Directory*, a catalog of vendor and product information and a complete editorial index. Many of you have asked if we are doing another edition this year. No, we are not, but I



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am happy to tell you that all the information contained in the directory is available from other sources.

For vendor and product information, contact Data Sources, a sister Ziff-Davis publication in Cherry Hill, New Jersey. Data Sources publishes a three-volume reference on hardware, software, and connections. Your $475 subscription also buys hot-line research services. Data Sources can be reached at 609/354-4999.

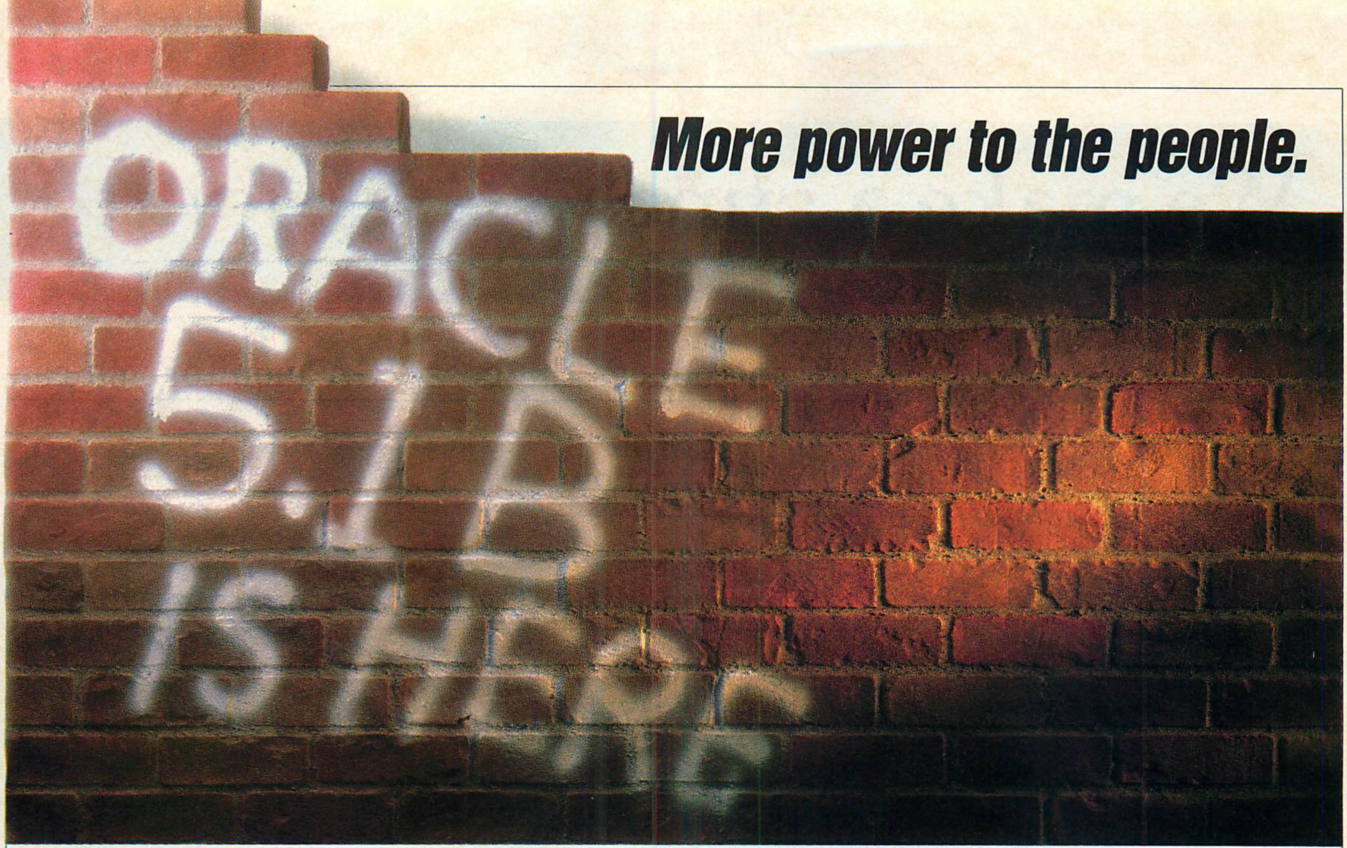
For an index to *PC Tech Journal* articles, you have several choices. PCTECHline (301/740-8383), our on-line reader service, now carries a downloadable version of our editorial index, which replaces the previous on-line search system.

The index is available in yearly increments (from volume 1, number 1 in July-August 1983), either with or without article abstracts. You can download the index into your favorite data manager or text editor. Each month we will publish the current issue's index, so you can update your downloaded version. We do not charge for this service; you pay only for the call.

Another source for an editorial index is KH Associates in Raleigh, North Carolina (919/846-7059). KH has announced MicroNewsIndex, which includes not only *PC Tech Journal*, but also five other PC publications. KH Associates, which built MicroNewsIndex using Fox Software's FOXBASE, distributes the index files in .DBF format and allows readers to search for articles using key words. Subscriptions are available for any combination of magazines from one ($89) to all six ($298). Back issues beginning with January 1988 are available at a modest charge. KH Associates also has volume discounts and site licensing.

If you would like past *PC Tech Journal* issues in electronic form, Ziff Communications publishes Computer Library, a CD-ROM service (updated monthly) containing the full text of articles printed during the last year in *PC Tech Journal* and nine other computer magazines (more are planned). Computer Library also abstracts another 120 computer, communications, and business periodicals. A 12-month subscription is $695 (plus $25 shipping and handling). Ziff Communications also sells Sony CD-ROM drives for $635 (with a subscription to the Computer Library). A network version of Computer Library will be available in the first quarter of 1989. Call 212/503-4400 for more information.

More power to the people.



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PC MAGAZINE EDITOR'S CHOICE

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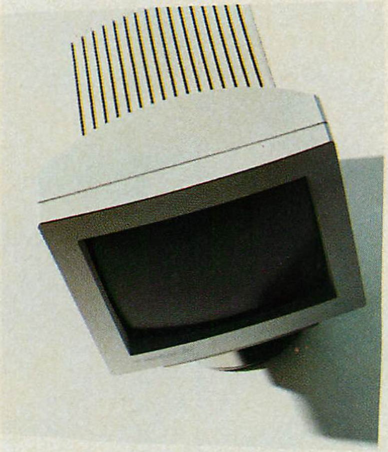

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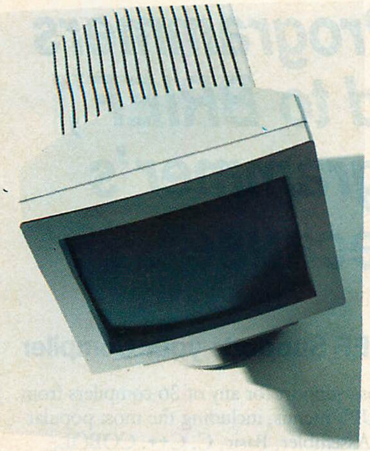

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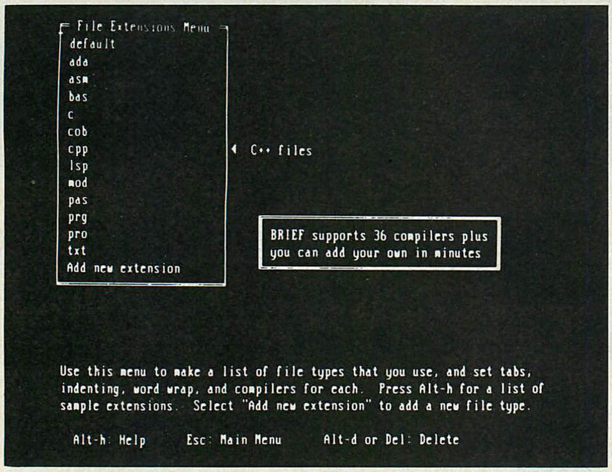

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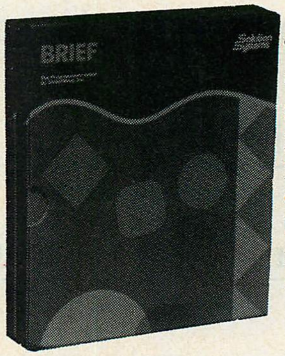

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LETTERS

SEARCHING IN UNIX

In your December 1988 article concerning application program interfaces ("At the Core: An API Comparison," Robert R. Morris and William E. Brooks, p. 62), the table listing Unix and OS/2 services claims that Unix has no directory search routines. This is untrue. System V release 3.0 and later have directory search routines built into the standard C library (**libc.a**). The routines **opendir**, **readdir**, **rewinddir**, **seekdir**, and **closedir** provide the functionality of DosFindFirst and related routines of OS/2 (and DOS). These routines also are available for previous versions of Unix from the Usenet archives in source form.

Eric Schnoebelen
John W. Bridges & Associates Inc.
Lewisville, TX

*Although the Unix routines do allow access to the file names in a directory, they do not actually search for file names as their OS/2 relatives do. The OS/2 DosFindFirst routine takes a file pattern and an access mode, so you can specify, for example, that just the read-only files matching the pattern *.EXE should be returned. The Unix routines return the name of every file (and subdirectory) in the directory.*

Actually, Unix equivalents to DosFindFirst and DosSearchPath are easy to implement. They are not, however, provided as a standard part of the Unix operating system, so the table indicates that they are not available.

*As for the remaining areas where OS/2 currently has the edge over Unix, AT&T has announced plans for System V release 4.0 that includes **setrlimit** to increase the number of open files; a new flag to the **open** call that specifies unbuffered I/O to disk; **fsync** to explicitly flush buffers for a file; and **priocntl** to provide realtime priority control for processes. That really evens things up between Unix and OS/2.* —DWM

EISA: PRO AND CON

In reference to the comments by Will Fastie in the December 1988 issue ("EISA: A Mistake," New Directions, p. 21), I am puzzled why the author felt compelled to reach the conclusion implied by its headline. He went on to state that "The Micro Channel is a superior technical solution by at least a small margin." But then he confessed that he did not obtain a copy of the draft of the Extended Industry-standard Architecture (EISA) bus specification. It would be judicious to find out more information before leaping to a conclusion. The article contained a considerable amount of useful information, but the author has done himself a disservice by indulging in speculation.

I think it would be more honest if the author had summarized his views on the EISA and Micro Channel controversy in the following terms:

1. EISA is an attempt by non-IBM manufacturers to avoid costly IBM licensing agreements and preserve the open architecture that gave the PC world the tremendous vitality to produce so many third-party accessories and software packages.
2. It probably will be two-and-a-half years before the availability of third-party add-in boards for the Micro Channel bus is equivalent to what is now available for AT-bus-compatible machines. Even if the EISA machines are not available until late 1989, at that time they will be more capable than the Micro Channel-bus machines of providing "total systems solutions" for users.
3. The technical superiority of one bus versus another seems to be unanswered, but in any case, it is certain that both buses will enable much more power and capability to be built into desktop machines. The vast majority of the user community does not have an immediate need for this additional capability.
4. Regardless of which bus architecture predominates, one thing is certain—the AT bus will thrive for at least another six to ten years.

If technical considerations necessitate the immediate purchase of a desktop machine with a 32-bit bus, the PS/2 would be the choice (by default). If no technical considerations require this type of bus, the purchase of an AT compatible would be sufficient and, as stated before, these machines will not be obsolete for a long time.

If technical considerations require a workstation with a 32-bit bus and a decision can be postponed, it would be prudent to wait for more information.

Thomas E. Beeler
Seattle, WA

I wish it were possible to find out more about the EISA specification, but it is still being held in confidence. It is the EISA consortium, most notably Compaq, which is forcing speculation on our part by touting EISA as superior to the Micro Channel without really telling us what it is, a position to which I object but cannot control.

Your summary is thoughtful and makes some good points. Let me comment on each point in the order you presented them.

1. *Licensing agreements with IBM cannot be avoided with EISA. According to the U.S. Patent Office, IBM owns the AT architecture; presumably, it will likewise own the Micro Channel architecture. We (and Compaq) may not like it, but those are the facts.*
2. *We certainly have to agree that an EISA machine, because it can accept existing add-in boards, will show greater flexibility in configuration and expansion. Not everyone needs that total flexibility, however; for that majority, it is important to deploy cost-effective solutions that minimize support, increase reliability, and meet the needs of the typical busi-*

ness user. I think the Micro Channel contributes significantly to that end.

3. *The benefits of automatic configuration and power-on self-test (POST) are delivered to every Micro Channel-based machine, even those with a 16-bit bus like the Model 50. These are not trivial issues from a systems administration perspective, especially in companies with large PC populations. The 16-bit version of EISA is the industry-standard architecture, which offers nothing but a glue to the past.*
4. *I think it more likely that AT-bus machines will* survive *because they will be so inexpensive—"thrive" may be too strong a term. The architecture that thrives will be the one that delivers the greatest benefit over the broadest price range of desktop computers.*

I agree with all but one point in your proposed course of action: if the choice of an AT-class machine is adequate, and there are no add-in obstacles, why not also get the advantages of Micro Channel? —*WF*

Thanks for Will Fastie's honesty in "EISA: A Mistake" (New Directions, December 1988, p. 21). I completely agree with him.

If the compatibles industry must use a bus not requiring IBM's license, it should consider existing high-performance buses such as NuBus or VME. A generic computer could be built on the NuBus that, with different processor cards, could be a Macintosh II (with a 680*x*0 processor) or a PC/AT or PS/2 (with an 80*x*86 processor).

Ramer W. Streed
North Mankato, MN

A RIGHT TO KNOW?

I must take issue with the position of Randall Stokes in his letter on the publication of data structures ("Data Structure Debate," December 1988, p. 16).

Data record documentation should be published as a technical reference manual by developers of all popular software products. Doing so does not damage the developer's rights or permit infringement of the copyright on the licensed product. Executable program code is essentially what the developer is licensing. Data files created by the user as a result of using the executable program are the property of the user. The user has a right to full access to these output files, and that access is denied by virtue of not publishing the data structures involved.

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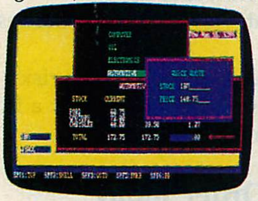

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Mr. Stokes appears to worry that the user is too stupid to be permitted to know the mysterious contents of his own output files. I submit that if the user messes up his files, that is his problem; the developer's concern is only to provide a product that works as claimed. Further, if the original developer goes out of business suddenly, there is a vast pool of users who will be stuck with expensively produced and maintained files that cannot easily be ported to another application. Such users are being cheated. Many users have a need to process data-file output from one application for use in a different application.

As a programming professional from the mainframe world, I further note that licensees of mainframe software products are routinely provided data-record layouts for all files used by the software product. Mainframe users demand them; they have billions of dollars invested in those data files and cannot afford instant obsolescence of that data if the software vendor goes out of business. PCs may be small, but there sure are a lot of them out there; those users are beginning to appreciate that the value of their data files far exceeds the original cost of the licenses for the software that created that data.

I interpret Mr. Stoke's comments as thinly veiled insults to the user community. As computing professionals, we can do without this kind of attitude toward the user. Developers must struggle for market share as it is; that market share would be vastly improved if there were an attitude of respect for the user and his needs.

Mr. Stokes also implies that the developer has reached that heavenly state of perfect data integrity (it adds, it looks right, it makes sense, it works!) at the time of product release. Nothing could be further from the truth. Developers are human, too. They make mistakes. A user has a perfect right to protection from corrupted data that might have resulted from programmer *X*'s migraine headache or whatever.

The final argument for publishing data record structures is also the simplest. Like shrink-wrapped licenses and copy-protection protocols, even the most abstruse data record can be conquered with patience and time. All you have to do is dump the output of software package *X* in hexadecimal format and study it. Then you play with it. It may take time, but with great patience, the record structure can be deduced, at least enough for the task at hand.

Publishing the data record structure simply serves these individuals who in turn are actually serving the developer community by making a product more accessible and useful to the user. A user who can port data files based on documentation provided by the developer is unlikely to turn away from that developer in disgust.

Sadly, "personal computing" will never become "useful computing" with the present copyright infringement hysteria in the minds of most developers.

Robert Lee Cochran Jr.
Providence, RI

OPERATING SYSTEM CHOICES

This is in response to the reader opinion card in the December 1988 issue of *PC Tech Journal.*

In answer to the question, "What criteria do you use in choosing an operating system?", as a systems planner and integrator, I generally choose an operating system based on the given project's needs or demands. These can include, but are not limited to, single- or multitasking needs, single- or multiuser needs, future plans for the project, costs (what will provide the demands without cost exceeding benefit), and current resources.

These are in no order of priority; that depends on the project. My specific criteria really change from project to project. An operating-system developer should strive for a system with the functionality of Unix, the affordability of DOS, and an interface such as the X Window System with an object-oriented programming language as its base development language. This environment should be able to interface automatically with any peripheral device. These are dreams—not so much the technology as the affordability.

I think this is where OS/2 comes in. It is much more affordable than Unix right now, even if it is not as fully flexible. (I realize that Unix is flexible at the expense of being expert-friendly and that OS/2 is not inexpensive.)

Actually, this is when Steve Jobs's NeXT machine and the NextStep operating system become very interesting. The price of a NeXT with all the bells and whistles is only $6,500. The catch is you must be an "academic institution." The important revelation will be what Jobs plans on charging the rest of the world for his machine. He certainly is on the right track in spite of the many disappointed expectations the acclaimed critics had.

As a corporate software developer, I really don't use criteria for choosing an operating system. If I need everyone to use a software package, I write it or have it written for every operating system we use. This is sometimes limiting for a mainframe (where the operating system is not so agreeable).

In answer to the question, "Which operating systems do you use or plan to use for application development?", I plan to use Unix (DEC and Sun), OS/2, Macintosh (both finders), DOS, IBM's VM-SP CMS and CP, IBM's Application System (up and coming and not my choice), as well as some very specialized environments. I am also investigating environments such as Microsoft Windows and the X Window System.

Richard Oppenheimer
Laurel, MD

ERRATA

In the article "Hardware Assistance" (Marty Franz, January 1989, p. 59), the address given for The Periscope Company is incorrect. The correct address is 1197 Peachtree Street, Plaza Level, Atlanta, GA 30361.

Also in the January 1989 issue, the incorrect phone number for VIA Information Systems Corporation, manufacturer of VIA/DRE database server, was given in Tech Releases (p. 45). The correct number is 609/243-0433.

In the February 1989 issue, the incorrect address and phone number were given in Tech Releases (p. 40) for Austek Microsystems Proprietary Inc., the manufacturer of the A28285 cache controller. The correct address and phone number are 2903 Bunker Hill Lane, Suite 201, Santa Clara, CA 95054; 408/988-8556.

PC Tech Journal regrets these errors and any inconvenience they might have caused.

COMMENTS WELCOME

All letters to the editor should be directed to Editor, *PC Tech Journal*, Suite 800, 10480 Little Patuxent Parkway, Columbia, MD 21044. Correspondence also can be submitted over MCI Mail to PCTECH.

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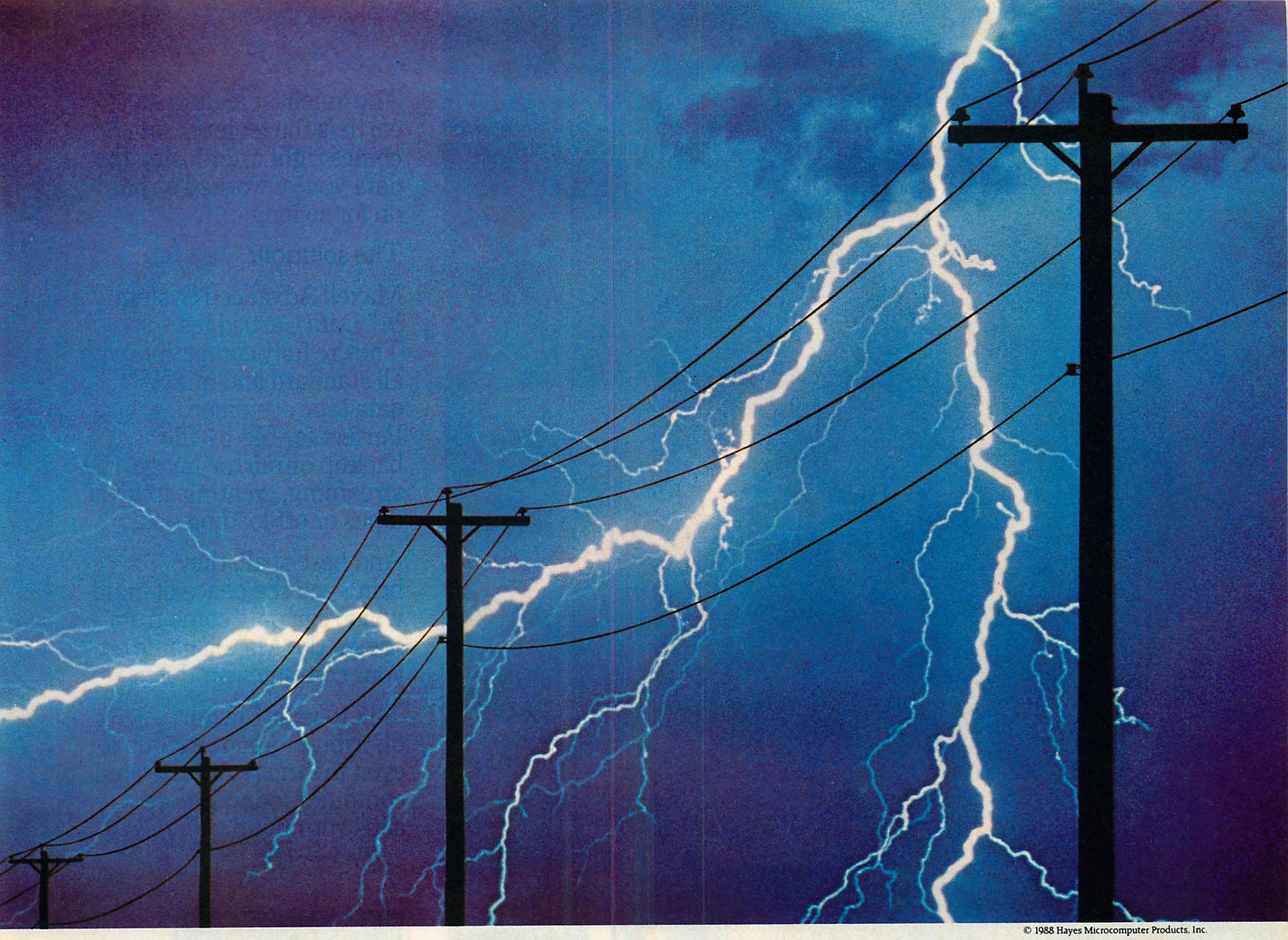

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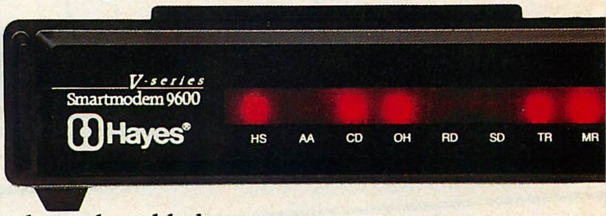

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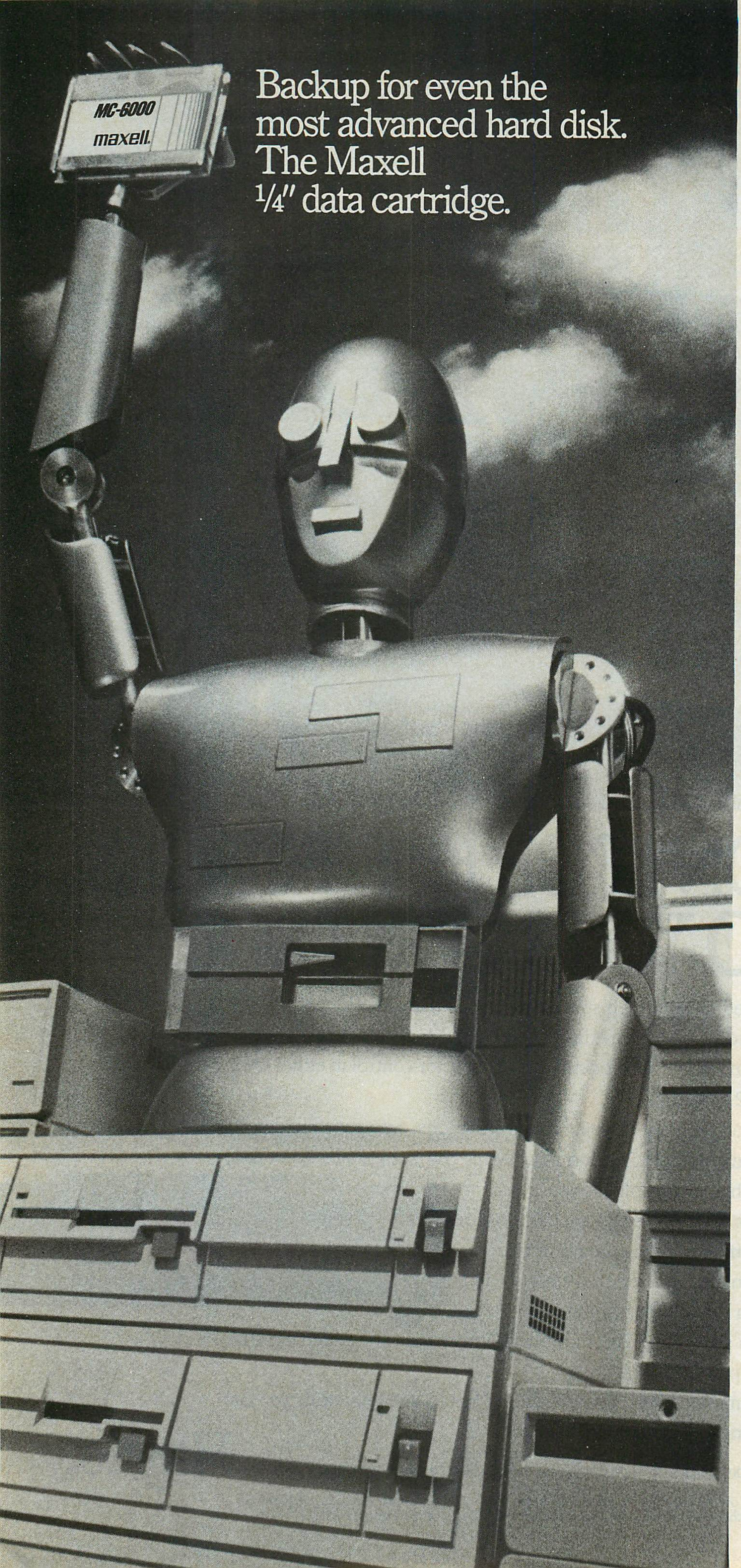

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NEW DIRECTIONS

Still Waiting for OS/2

OS/2 is here, but is it really? □ Also, is DOS 4.0 in trouble? □ And IBM's next generation of graphics adapters.

IBM's recent emphasis on the PS/2 and Micro Channel in the wake of the Extended Industry-standard Architecture (EISA) announcement has overshadowed the arrival of the last of the promised OS/2s: Extended Edition 1.1 and, to a somewhat lesser degree, Standard Edition 1.1. Both versions incorporate Presentation Manager; Extended Edition also includes IBM's data-management solution (see "OS/2 Meets SQL," Herbert A. Edelstein, February 1989, p. 62) and the IBM LAN Manager. IBM and Microsoft are pressing their case for OS/2. Their message: OS/2 has arrived.

That assertion must be taken guardedly. First, the pressure on both IBM and Microsoft to meet deadlines (Standard Edition 1.1 hit the streets on the very last day of October, the promised month) means that Presentation Manager is not as "cooked" as we might have liked. Bugs have been reported, and performance is still an issue, especially for high-resolution screens such as IBM's own 8514/A. Second, and far more important, the availability of OS/2 does not necessarily mean we can take full advantage of it.

Where does that leave us? If OS/2 is available, but hasn't arrived, when will it do so? How should we plan for OS/2? Should we plan for it at all? Can we count on a strong OS/2 strategy from IBM and Microsoft? Where are IBM and Microsoft headed? In the context of a broader OS/2 strategy, what is the life span of DOS?

ACROSS THE ABYSS

A variety of difficult problems faces integrators of OS/2. First and foremost is the lack of available applications. Oh sure, IBM will pull out its catalog of software products, but a simple experiment proves the point. List your five most important applications, your network environment, and your two most important network utilities (E-mail, for example). Now, check off each one that is available *today* under OS/2. Don't worry about Presentation Manager; a character-based version of the application will suffice for the moment.

How's your list? For my money, you need to check off every item on that list but one—you can struggle along with a single DOS application in the compatibility box for awhile. What this experiment points out is that none of us is willing to move to OS/2 until we can do so without disrupting the normal course of business. That leaves vendors with a classic chicken and egg problem; if we tell them we are not using OS/2 because there are no applications, what will induce them to port their applications? The fact that IBM is behind the new operating system is incentive enough.

This should mean that the immediate future of OS/2 is bright; many vendors, however, have opted to go directly to the Presentation Manager version of their software. Given the learning curve for Presentation Manager and the necessity to redesign most text-based packages to conform to the new user interface, development will take considerably longer than a direct port of a character-oriented product. Well-designed text-based products, such as Microrim's R:BASE (see "Porting to OS/2," Steven Armbrust, November 1987, p. 140), can be ported very quickly; a prototype of R:BASE was demonstrated in a prototype of OS/2 on the day PS/2 was announced.

WordPerfect Corporation is more typical. WordPerfect in both OS/2 forms is under development, with the text version expected in March and the Presentation Manager version planned for December. Having WordPerfect, dBASE, and Lotus 1-2-3 in place (or substitute your favorite product in each of these categories) represents an important milestone for OS/2 and you. Even with these packages ready to go, however, most conversions to OS/2 will still be stalled by other missing pieces.

One of the most important missing pieces is networking. OS/2 Extended Edition 1.1 (which includes the LAN Requester), IBM's OS/2 LAN Server, and Microsoft's LAN Manager are all available, making OS/2 servers possible. Unfortunately, the world stores its data on Novell servers.

To date, Novell's direction is unclear. Its support for OS/2 is limited to an OS/2 Requester module that enables an OS/2 workstation to talk to an existing NetWare 2.11 server—an obvious stopgap measure. Novell's network util-

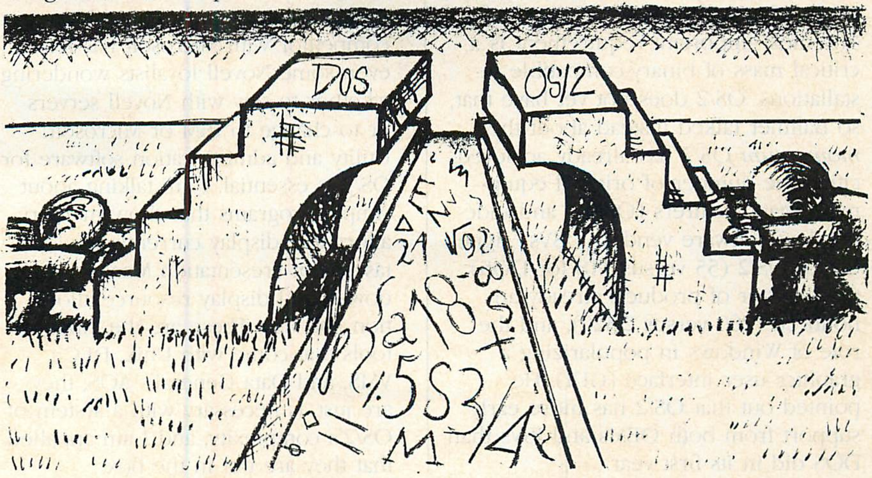

ILLUSTRATION • MACIEK ALBRECHT

ity programs have been generated for OS/2; however, most of the third-party utilities are not yet available for OS/2, and even if they were, it is not clear that Novell's current solutions represent a complete bridge between the DOS and OS/2 worlds.

It is a certainty that this bridge must exist. There are far too many DOS-based machines to ignore. Many of these computers are networked, and although not all are suitable for OS/2, the older machines should be able to participate in the connectivity strategy. Someone doing nothing but word processing and using E-mail can certainly continue to do so without an expensive hardware and software upgrade.

Furthermore, in true democratic fashion, DOS machines and their networked applications represent the majority, while OS/2 is the new guy on the block. The integration of OS/2 must, therefore, be carried out in a manner that bends over backwards to accommodate DOS.

DOS and OS/2 are building bridges from either side of a yawning chasm, but they do not quite meet in the middle. So, for example, a new OS/2-only network with a new in-house application could be deployed on OS/2 using either IBM's or Microsoft's networking solution with no difficulty. It could even run some of the available applications—WordPerfect, Borland's Paradox, and so on. Factor in existing DOS workstations, servers, or in-house applications, and the picture changes dramatically—so much so that it is unclear if data can be shared, if applications are interoperable from DOS to OS/2, or if popular network software will work.

At a December 1988 press briefing at IBM's UK Laboratory at Hursley Park, England, Steve Ballmer, Microsoft's vice president of systems marketing, spoke about what will make OS/2 successful. The most important requirement is a critical mass of binary-compatible installations. OS/2 does not yet have that, so Ballmer talked instead about the *momentum* OS/2 has already achieved, citing the number of original equipment manufacturers (OEMs) and independent software vendors (ISVs) signed up for OS/2 (55 versus 118 for DOS), the number of products already announced (200 versus 2,320), and the role of Windows in popularizing a graphics user interface (GUI). He pointed out that OS/2 has more early support from both OEMs and ISVs than DOS did in its first year.

Momentum is not critical mass, however. Critical mass will be achieved only when the following milestones have been reached:

- Versions of OS/2 with Presentation Manager must be available from more than just IBM. At the very least, other OEMs must provide drivers that will allow the native IBM version to work on their compatibles by exploiting vendor-specific peripherals or subsystems. Among ALR, AST, Compaq, and Dell, none has Presentation Manager yet. AST plans to have its own version in the second quarter, and ALR is the only vendor to say that IBM OS/2 1.1 does run on its equipment. Until buyers of non-IBM equipment can be given the confidence a second source provides, OS/2 cannot reach critical mass.
- A preponderance of applications is necessary. The definition of preponderance is personal: it means the applications *you* need must be available. Generally, for the majority of situations, all the needed applications, or at least the most important ones, must be available.
- Network operating software from the major vendors must be available. These solutions *must* include the bridges between DOS and OS/2. The fact that Microsoft's LAN Manager makes no attempt to address the Novell reality is an inhibitor.
- The most popular network applications must be available, especially E-mail and utilities.
- The role of the LAN Managers from IBM and Microsoft, or perhaps from Microsoft's OEMs such as 3Com, must be clarified. The issue of interoperability with the IBM OS/2 LAN Server and OS/2 Extended Edition also needs clarification.
- Novell must show greater progress along its stated (although still not definite) migration path. Its position as a competitor with Microsoft has left even some Novell loyalists wondering whether to stay with Novell servers or to change to IBM or Microsoft.
- Utility and administration software for OS/2 is essential. I am talking about simple programs that show memory allocation, display currently loaded tasks (not Presentation Manager windows), and display resource allocation and use. These are the kinds of tools that come with Unix, DEC's VMS, and Data General's AOS; they are just as necessary with a system of OS/2's complexity, and I am appalled that they are not in the box.

Most of these items are in progress, although it will probably be another year before everything is in place. That does not leave much room for OS/2, except for dedicated applications in OS/2-only installations, and that creates another problem. If OS/2 is not being installed now, how will businesses gain the necessary OS/2 experience—the kind of experience that is so important for strategic planning but that only time buys?

The answer is that OS/2-based LAN servers are the most important OS/2 product on the market today. Assuming that a DOS-based LAN requester is available, OS/2 servers offer the opportunity to deploy OS/2 in a way that does not interfere with day-to-day workstation activities, while at the same time providing systems developers and integrators with ample opportunity to experiment. Over time, a few prototype OS/2 stations can be added to expand the experiment. Eventually, the workings of OS/2 will be understood, the necessary bridges will be in place, and both OS/2 and DOS workstations can be added to the network.

There is an ironic twist of fate here. Unix could have played the role of server operating system just as well as OS/2—and much sooner. If Unix had been able to establish a beachhead serving networks, it would have had a much better shot at becoming the desktop operating system of choice. I have to wonder how the Unix industry managed to miss that opportunity.

THE IBM PITCH

The Hursley Park press briefing in December was billed as a discussion of Presentation Manager and graphics directions, but turned out to have significant, generic OS/2 content. The site for the briefing was chosen because the Hursley Lab is responsible not only for Presentation Manager, but for PS/2 graphics adapters (VGA, 8514/A), PS/2 monitors, and all versions of the graphics data display manager (GDDM).

Although most of the presentations were at a relatively nontechnical level, the briefing did yield the most clearly articulated IBM context for OS/2 and Presentation Manager that I have yet heard. Specifically, IBM described how Presentation Manager had evolved through GDDM, graphics control program (GCP), early IBM graphics hardware, OS/2, and Microsoft Windows. IBM also put Presentation Manager firmly in the Systems Applications Architecture (SAA) and Common User

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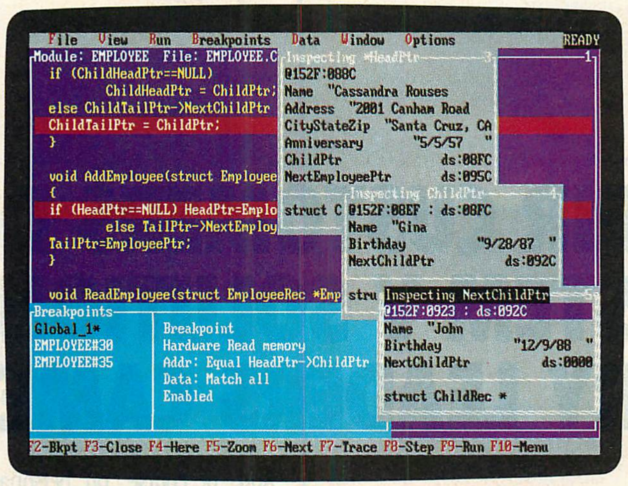

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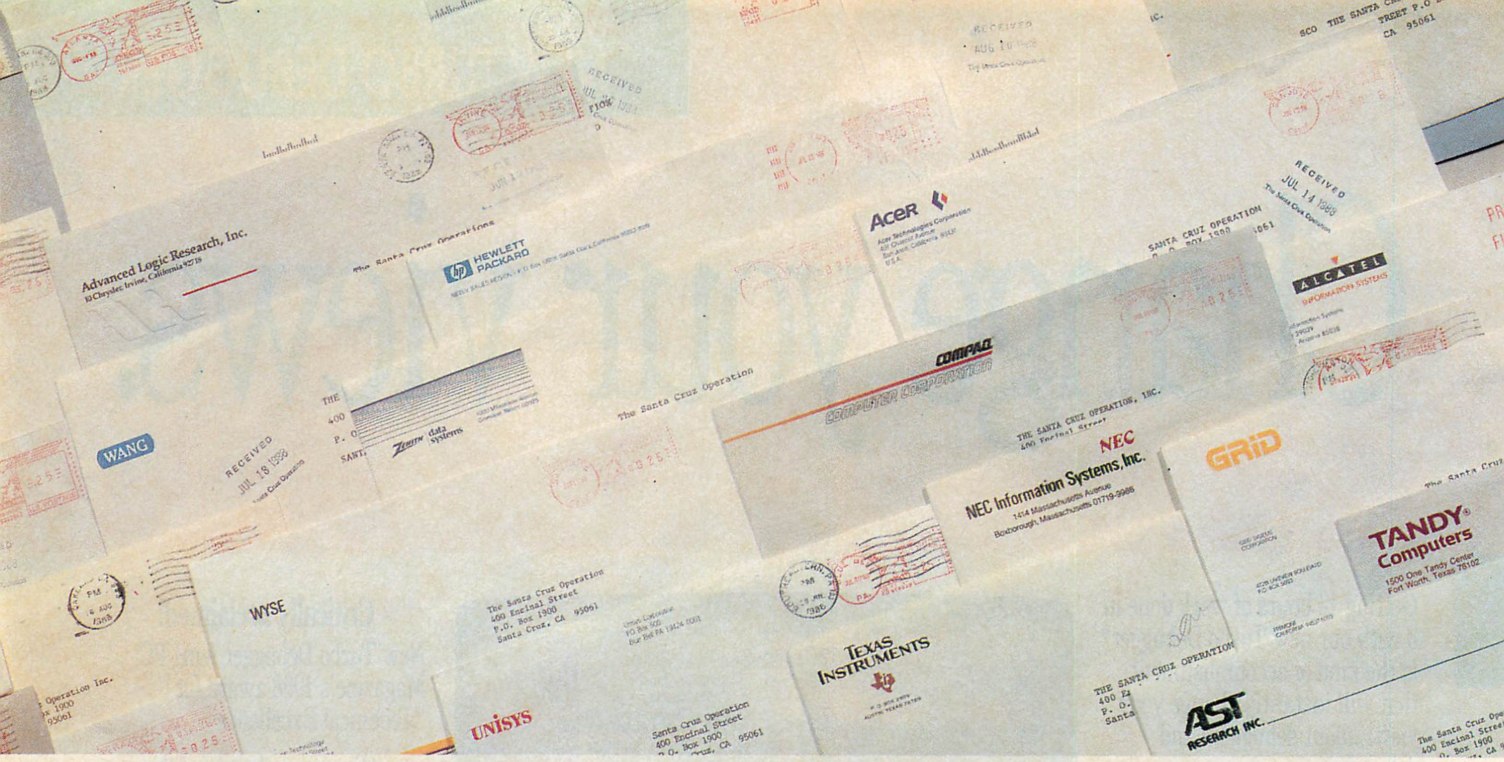

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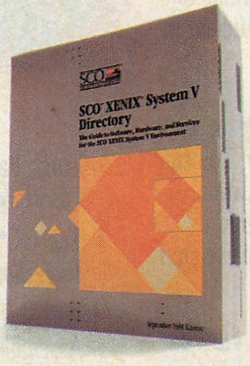

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Access (CUA) context, a connection we know about, but that IBM has not really explained very well.

What IBM did not exactly say, but which I think is clear from what *was* said, is that Presentation Manager represents the cutting edge of CUA and thus will have a driving effect on both the evolution of CUA and an accelerating effect on the development of SAA. In other words, IBM is actually admitting that desktop computers will be the driving force in the overall systems architectures of tomorrow and will also be the execution unit upon which most applications will run.

That is very big news. IBM is certainly not conceding that there is no room for mainframes or its popular AS/400 minicomputer. It is saying that it is developing a comprehensive strategy for the complete integration of desktop computers into a distributed corporate computing environment. During several of IBM's presentations at Hursley, the issues of distributed applications and data kept coming up, a sure sign that IBM's key developers see the handwriting on the wall.

With luck, IBM's marketing side will see that handwriting as well, but the signs are not good. IBM's marketing is clearly dominated by a sales effort for big systems. Its marketing of PS/2 and OS/2 continues to be directed at its captive mainframe customer base, as opposed to the open market for desktop computers, furthering the flawed notion that PS/2 and OS/2 are inseparable and cultivating the myth that the important matter is PS/2 hardware rather than OS/2 software.

Furthermore, the elevation of Jim Cannavino to replace Bill Lowe as president of the Entry Systems Division represents an unknown. Cannavino comes from the mainframe side of IBM's business.

IBM's desktop business is being hurt by rapid management changes. Lowe represented continuity over the last few years; of course, that is apparently why he left. When the dust clears around Cannavino, I hope we will see that he understands how desktop computing is changing corporate computing, and how important a widely distributed, critical mass of binary-compatible OS/2s is going to be not only to IBM, but to the industry at large.

WHY OS/2?

When I ask people about OS/2 and their integration plans, the answers range from "nothing" to complex stra-

tegic systems. I am surprised at how often I hear "DOS can do everything I need." Well, it just isn't so, and it's getting worse.

Four features distinguish OS/2 (or any standardized, multitasking system for that matter) from DOS.

- The elimination of the 640KB barrier of DOS is an underrated benefit of OS/2, primarily because Intel did such a brilliant job inventing a market for expanded memory. EMS has become a holding action against the advent of OS/2 and leads some integrators to believe that the memory problem is not terribly severe. However, the good applications we have now need room to grow without resorting to overlays or explicitly coded expanded-memory strategies; and new applications, previously thought difficult or impossible in DOS, are immediately enabled by the considerably larger address space of OS/2. Griping about the cost of memory is unrealistic; sooner or later, that memory has to be bought to solve DOS problems, too, and the price is on the way back down anyway. And by the way, as good as expanded memory can be, confusion over conventional, extended, and expanded memory is still legion, not to mention confusion over how to allocate each kind among executable memory, disk cache, RAM disk, or EMS.
- Configuration of OS/2 under software control, although still primitive, holds great promise for improved systems administration. Little can be done to improve DOS in this way. A problem every systems administrator must face is that, while standardized systems are desirable for the administrator, they reek of control and inflexibility to the user, who will always view the PC as his or her machine. Two extremely important considerations are dynamic configurability and the ability to determine quickly (and perhaps remotely) what that configuration is.
- "Why do I need multitasking?" is the big question I hear about OS/2. The question should be not why the *user* needs multitasking, but why the *operating system* needs it. What multitasking really buys is a standardized, low-overhead way of getting tasks done in the background. Print spoolers are the most easily understood example, but communications tasks will be the most important corporate benefit. Developers will see numerous benefits, from overlapping compiles and edits to testing both halves of a communications session in the same machine.
- Finally, OS/2 greatly simplifies, regularizes, and standardizes the process of add-ins to the operating system itself. OS/2 trades in the ugliness of terminate-and-stay-resident (TSR) programs under DOS for the smoothness of installable drivers and the cleanliness of independent but communicating tasks. OS/2 also enables a clean, fully supportable way for a peripheral manufacturer to supply driver software without anyone having to worry about who is on top of the stack for the keyboard interrupt or, worse, the DOS interrupt itself.

These are worthwhile benefits. Personally, I am tired of the hassles created by DOS in complex situations. I have avoided TSRs like the plague for the past several years in an attempt to prevent interactions; unlike the prescription medicine industry, which now offers computer systems to catch problems from potential drug interactions, the only advice a TSR vendor gives is "make sure UltraTSR is installed LAST!"

Even so, my CONFIG.SYS file has a stack of drivers that keeps growing and that I cannot seem to cut back. My

computer, which runs Windows/386, also runs on a network, but not when Windows/386 is loaded. Running Windows, LAN software, and several TSR-style drivers leaves little room for applications in 640KB. I want to add CD-ROM extensions, but that's another chunk of base memory.

Why all the trouble? The reason is that these programs were not designed to work with one another. What few rules DOS imposes are regularly broken. Not until customers complained about incompatibilities were patchwork solutions devised to overcome them—for example, the TASKMODE command for Novell NetWare, a system variable that is set to 0 but that should be set to 1 if Windows/386 is going to be used. Can you imagine this horror being carried to its logical conclusion? You would have to tell every application about every other application, as well as the configuration of the underlying operating system, in order to get those applications to cooperate.

WAIT FOR IT . . .

PC Tech Journal's business is conducted by a network of desktop computers not unlike that in many firms. Our technical editors need to study OS/2, however, so our situation is aggravated. Because the DOS-to-OS/2 bridges are not in place, those who study OS/2 use Ted Mirecki's dual-boot technique (see Tech Notebook, September 1988, p. 137 and February 1989, p. 132) to switch between DOS and OS/2 as needed—DOS to do business and OS/2 to do research. The OS/2 versions of the applications we use are far from ready, and probably will not be until at least December, excluding network support and network utilities.

So what is the state of OS/2? Slow, is probably the best answer. So many promises, so many advantages, but still so long to wait.

DOS 4.0 IN TROUBLE?

IBM's DOS 4.0 has taken its share of heat. The first version got panned because of bugs; now IBM is shipping version 4.01 in the box (neither the box nor the VERSION command will say that, but the diskette label in my recently obtained copy did). It still suffers a few difficulties.

The world is not rushing to DOS 4.0*x*. Infocorp reports that of 10 million copies of DOS worldwide, 70 percent are versions 3.2 or 3.3, while 2 to 5 percent are DOS 4.0; the remaining 25 to 28 percent are DOS 2.1, primarily in the laptop market. This means that since the announcement of version 4.0, IBM (the only vendor shipping in quantity) has sold between 200,000 and 500,000 copies.

The situation is darkened somewhat by the fact that of four systems vendors with whom I spoke (ALR, AST, Compaq, and Dell), only Dell is shipping 4.0. Certainly no new version of the world's most popular operating environment is going to catch fire unless vendors are behind it.

Why are we not taking to DOS 4.0 any more rapidly? The two exciting features of the new version are its support for partitions larger than 32MB on a hard disk and its new user interface, called DOS Shell. (For a full review of DOS 4.0, see "DOS Marches On," Richard Wilton, January 1989, p. 98.) Both are important, but both are late entries. A number of add-in software products already allow larger partitions for large hard disks, a way to extend the life of a bought-and-paid-for DOS.

Likewise, DOS Shell has competition from several products, most of which offer advantages over the DOS 4.01 shell. The WordPerfect Library, Microsoft Windows, Quarterdeck's DESQview, Bourbaki's 1dir, Executive Systems' XTree, The Norton Commander, and others have become entrenched over the past two years; neither users nor systems developers are likely to change just for kicks.

Eventually, DOS 4.0 will prevail. Vendors will have to match IBM, operating system for operating system, and they will not like having more than one version of the operating system in their inventory. Unfortunately, that day will be longer in coming than for any previous version of DOS.

IBM'S NEXT GRAPHICS STEP

One of the subjects discussed at IBM's briefing at Hursley Labs was the next generation of graphics adapters. Although IBM generally sets the graphics standard, it invariably lags behind the aftermarket in terms of performance and features. Right now, for example, IBM offers only the 8-bit, built-in VGA on its PS/2s; the ghastly, horrible, who-cares MCGA on its least expensive models; and the pricey 8514/A adapter. The rest of the industry offers the so-called "super-VGA" adapters, which usually offer both a 16-bit data path and faster performance, as well as higher resolutions and more colors. (See "The VGA Parade," Kent Quirk, January 1989, p. 70.)

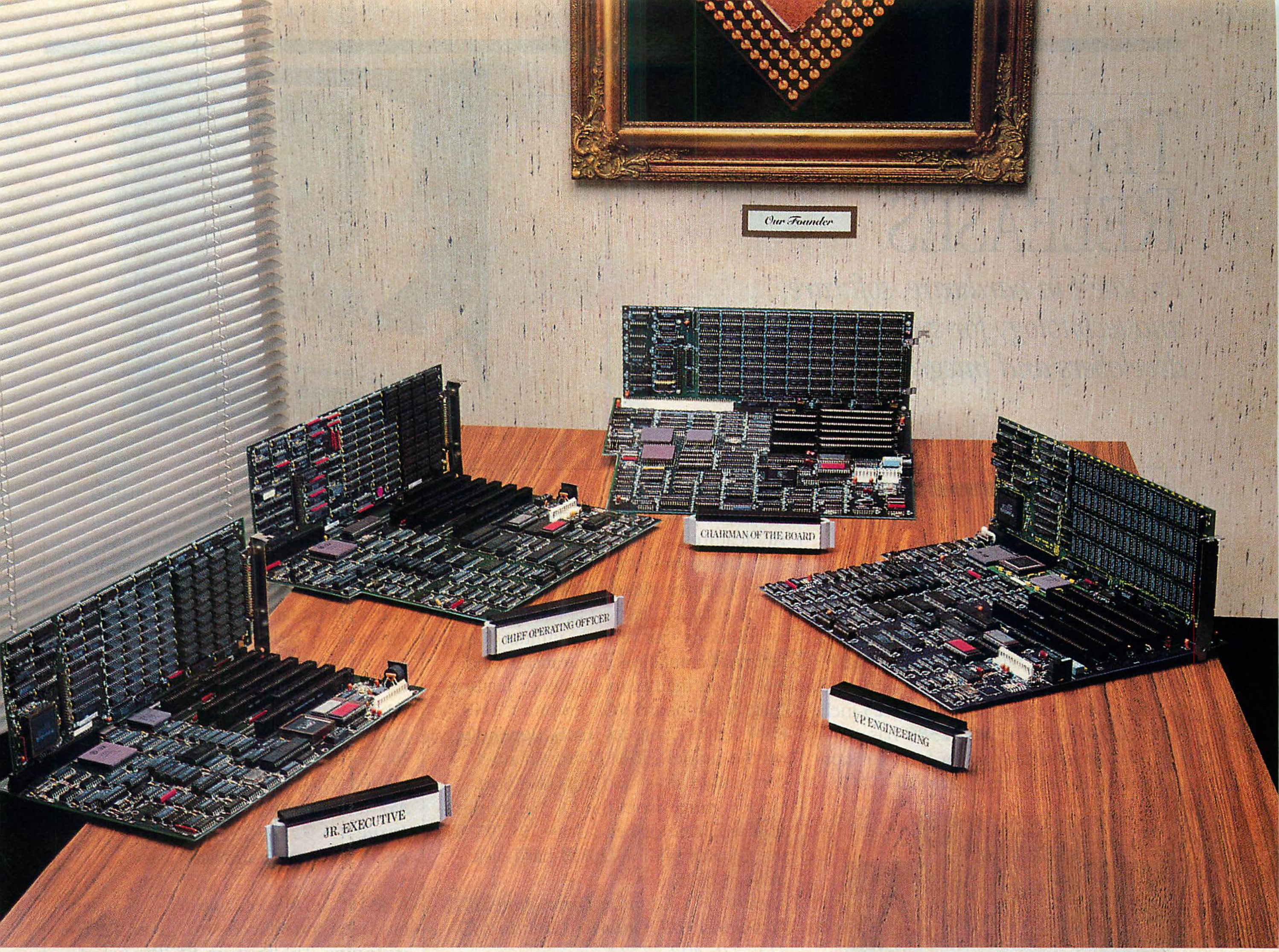
In typical fashion, IBM hardly opened its kimono. However, Peter McManus, Hursley's director of interactive systems products, made two rather definite comments—not product announcements, just comments.

First, he said that IBM customer demand would result in the availability of IBM solutions with palettes of 16 million colors within the year. Customer demand, of course, is the reason IBM gives for every move it makes. That McManus would point to color as a customer mandate is intriguing given that the IBM mainframe world is a vast, text-based wasteland. More likely, IBM's customers are speaking with their dollars and buying Macintosh computers whenever graphics is the driving requirement. The fact that IBM recognizes that problem and mentions even a vague time frame indicates great seriousness on its part.

Second, McManus just flat out said that "8514/A would find its way onto the planar." In other words, the built-in VGA chip will be replaced by 8514/A or equivalent functionality as a standard feature of IBM computers. In this case, sadly, he gave no time frame, although in an earlier conversation, Bill Lowe and Robert L. Carberry, vice president of systems, IBM Entry Systems, mentioned 1989 as the year in which IBM graphics and mass storage technology would become more competitive. I suspect the new graphics standard will happen on the high end first, but eventually, it will be just as cost-effective for IBM to build it into everything.

I asked several IBM executives at the Hursley meeting why IBM didn't just replace the 8-bit VGA with a 16-bit version, thus improving performance by a factor of at least two or three. Their answer surprised me. To a person, they said that such a move was a half-step, just a maneuver to catch up. What IBM intends to do is take a leap forward by setting a significantly advanced new standard. Sounds great, but it had better hurry.

Will Fastie is the editorial director and founding editor of PC Tech Journal.



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The 16-MHz MPS2386 from American Mitac

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American Mitac Corporation, 410 E. Plumeria Drive, San Jose, CA 95134; 800/648-2287; 408/432-1160
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A family of Micro Channel-compatible personal workstations based on Intel's 32-bit microprocessors, ranging from the 16-MHz 80386SX to the 25-MHz 386, has been introduced by **Apricot**. The central element of the **Qi** Series of PCs is the Integrated Network Systems (INS), which incorporates on-board Ethernet networking, communications (two additional serial ports), and security features.

The Apricot Qi software environment features Microsoft Windows/386, and a suite of desktop communications applications that provide utilities for terminal emulation, file transfer, and telephone management. Other features include on-board VGA graphics, 1MB of RAM (expandable to 16MB, depending on the model), four Micro Channel-compatible slots, and a mouse port. Models range from the Qi 310 workstation with one diskette drive, $3,795, to the Qi 660i with a 120MB hard-disk drive, $8,995.
Apricot, 111 Granton Drive, Suite 401, Richmond Hill, Ontario, Canada L4B 1L5; 416/492-2777
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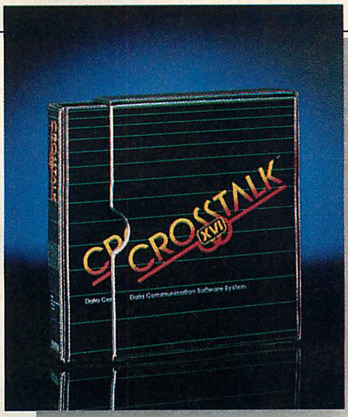
A family of enhanced Premium/386 computers from **AST Research**, designated **Premium/386C**, features an advanced cache-memory architecture and additional memory capacity. The AST Premium/386C operates at 20 MHz with a zero-wait-state cache memory architecture and 64KB of 25-ns static RAM. The machine supports 16MB of 32-bit memory, which is configured with AST's ASTEMM, an EMS 4.0-compatible, expanded-memory manager. The Premium 386/C includes the AST SMARTslot architecture, as much as 2MB of RAM, seven expansion slots, three user-selectable speeds, and a hard-disk capacity of as much as 640MB. An LED display designates the operating speed, which is user-selectable. The Premium/386C can accommodate a total of four drives—three half-height drives accessible from the front panel and one internal full-height drive. Prices range from $4,395 to $9,795.

Also from AST, the **AST Bravo/286** is an entry-level, 8-MHz, zero-wait-state, 286-based microcomputer. Standard features include 512KB of RAM, four expansion slots, a diskette controller, serial and parallel ports, and support for an 80287 coprocessor. The AST Bravo/286 can accommodate as much as 4MB of RAM on the system board and 16MB total system memory with optional memory boards. The computer incorporates four full-length, AT-height expansion slots, including one 8-bit and three 16-bit slots. The AST-Cache disk-caching program for reducing hard-disk data-access time is included. Diskless version, $1,095.
AST Research Inc., 2121 Alton Avenue, Irvine, CA 92714-4992; 714/863-1333
CIRCLE 301 ON READER SERVICE CARD

A 32-bit, small-footprint desktop system has been introduced by **Ogivar Technologies**. The **System SX386**, based on Intel's 16-MHz 80386SX microprocessor, comes standard with an IBM-compatible, 101-key enhanced keyboard, 1MB of RAM (expandable to 16MB—8MB on the system board and 8MB on the expansion board), a 1.44MB 3.5-inch or a 1.2MB 5.25-inch diskette drive, a socket for an Intel 80387SX, and MS-DOS 3.3 (MS-OS/2 is optional). Storage options include a 102MB hard-disk drive. $3,200.

Ogivar Technologies has also announced a 32-bit laptop based on the Intel 20-MHz 386. The **Ogivar 386** operates in both the OS/2 and DOS environments. It is configured with a 40MB hard-disk drive, a 720KB 3.5-inch diskette drive, a socket for an Intel 80287, and 2MB of RAM. The Ogivar 386 weighs 17.8 pounds and measures 14 inches wide, 15 inches deep, and 4 inches high. $8,500. Ogivar Expansion Chassis, $336; external diskette drive, $530; 1,200-bps modem (internal or external), $635; 2,400-bps modem (internal or external), $835.
Ogivar Technologies Inc., 7200 Canada Highway, Laurent, Quebec, Canada H4T 1A3; 800/361-3694; 514/737-3340
CIRCLE 303 ON READER SERVICE CARD

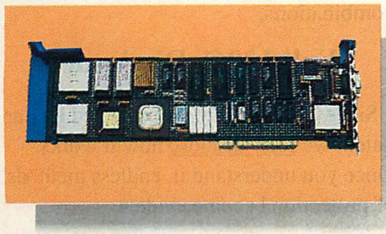
Ogivar's System SX386 desktop



Crosstalk XVI 3.7 from Crosstalk Communications

CONNECTIONS

IBM has repositioned its LAN products by introducing several new products and enhancing existing ones. The **IBM Token-Ring Network 16/4 Adapter** (for the IBM PC) and the **16/4 Adapter/A** (for Micro Channel PS/2s) operate at either 16 or 4 Mbps, with as much as a 17,997-byte frame size for 16 Mbps and a 4,501-byte frame size for 4 Mbps. Both have 64KB of RAM, RAM paging, a maximum of 254 link stations, and early token-release capability at 16 Mbps. IBM Token-Ring Network 16/4 Adapter, $895; 16/4 Adapter/A, $895.



IBM's 16/4 Adapter for the PC

The **IBM Token-Ring Network PC Adapter II** transmits and receives data at 4 Mbps, has 16KB of on-board RAM, and conforms to IEEE 802.5 and European Computer Manufacturing Association (ECMA) standards. $750.

The **IBM 8220 Optical Fiber Converter** is an electrical-to-optical and optical-to-electrical signal converter that is attached as part of the IBM Token-Ring Network and can operate at either 16 or 4 Mbps. The 8220 Optical Fiber subsystem consists of a pair of 8220s and the optical-fiber link between them. If power loss or failure occurs in the upstream or downstream 8220 Optical Fiber Converter, each 8220 in the affected subsystem will disengage from the ring and wrap the main ring to the backup ring at each end of the subsystem, maintaining continued operation. $3,000.

Version 2.0 of the **IBM Token-Ring Bridge Program** extends bridging functions to the 16-Mbps IBM Token-Ring Network and provides network-management support by forwarding ring- and bridge-error information to the IBM LAN Manager 2.0. **Version 2.1** (available in July) will provide a remote bridging capability for connecting geographically dispersed rings of the IBM Token-Ring Network. Versions 2.0 and 2.1, $1,595; upgrade, $305.

Version 1.1 of the **IBM Local Area Network Support Program** provides NETBIOS and IEEE 802.2 software interfaces to support LAN programs that use the IBM network adapters on the IBM Token-Ring Network and the broadband and baseband IBM PC Networks. It supports the function and operational environment of the IBM LAN Support Program version 1.0. $60; additional licenses, $40.

IBM Corporation, 1133 Westchester Avenue, White Plains, NY 10604; 800/426-2468 for nearest dealer

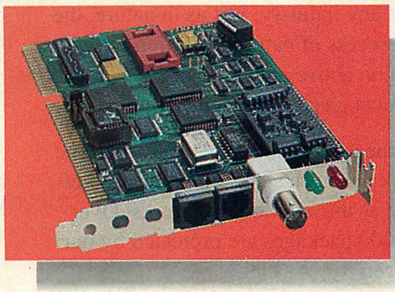
CIRCLE 310 ON READER SERVICE CARD

Version 3.7 of **Crosstalk XVI** is shipping from **Crosstalk Communications**. Capabilities include transferring files, awaiting incoming calls, running scripts, and performing communications tasks in the background. Also included are user-selectable hot-key combinations for background operation, full path-name support, and a new manual with more examples. An enhanced command-line editor allows users to recall, edit, and reenter commands by using the arrow keys. Commands that allow the user to specify error thresholds for file transfers and line inactivity timeout periods have been included. $195; update from earlier versions, $30.

Crosstalk Communications, 1000 Holcomb Woods Parkway, Roswell, GA 30076; 404/998-3998

CIRCLE 307 ON READER SERVICE CARD

A family of network interface controllers is shipping from **Yamatech**. The **TURBO ARCOM 16** is a half-size, 16-bit ARCnet LAN interface controller for the 16-bit AT bus or 32-bit 386 bus. Features include a true dual-ported, double, zero-wait-state RAM buffer, and surface-mount technology. The **TURBO ETHERCOM 16** is a half-size, 16-bit Ethernet LAN interface controller for the AT bus that features a buffer with as much as 64KB of RAM. It is totally software configurable and uses surface-mount technology. Two versions are available—one with thin and thick coaxial cable support, the second with 10-Mbps performance over twisted-pair Ethernet cable based on the upcoming ANSI 10BASE2 standard specifications.



Yamatech's TURBO ARCOM 16 network-interface controller

The **SUPER ETHERCOM** is a high-performance, full-size Ethernet LAN interface controller for the Micro Channel-based PS/2 Models 50, 60, 70, and 80. Its features are similar to those of the TURBO ETHERCOM 16-bit board, which is also offered in the same two configurations. TURBO ARCOM 16, $495; TURBO ETHERCOM 16, $595; SUPER ETHERCOM, $795.

Yamatech, 1255 Laird Blvd., Montreal, Quebec, Canada H3P 2T1; 514/737-5434

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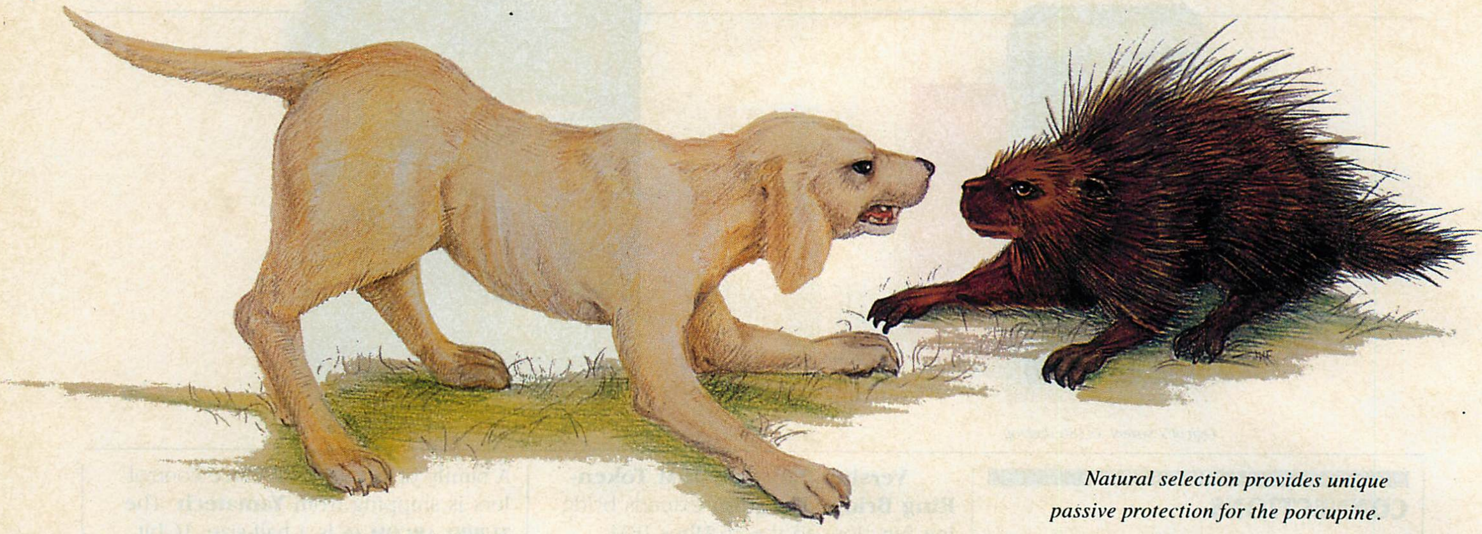
3Com and **Madge Networks** have jointly organized the **Open Token Foundation** (OTF), an industry-wide



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Once you program your part of the chip, even we have no way to access your information.

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Since The Activator is protected by our patent we fully disclose how it works. Once you understand it, endless methods of protection become evident.

Just as no two snowflakes are the same, no two implementations of The Activator are identical. And like the snowflake the simplicity of The Activator is its greatest beauty.

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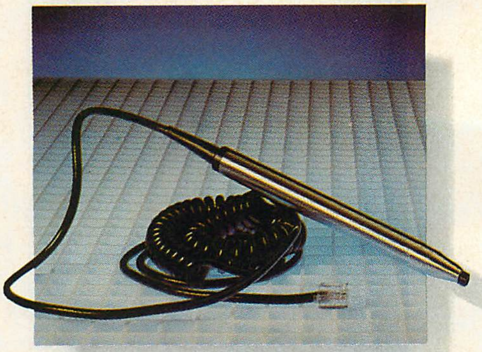


FT-1000 light pen from FTG Data Systems

Howtek's Scanmaster II digital color scanner

consortium of token-ring network manufacturers and users concerned with ensuring the interoperability among products based on IEEE 802.5 token-ring LANs as well as future fiber distributed data interface (FDDI) token-ring LANs. The OTF will promote product interoperability by supporting the development of vendor-neutral open systems that are based on token-ring technology. The OTF will provide a forum for discussing implementation and technical issues, thus increasing awareness of token-ring technology, products, and vendors. Users will be able to express requirements for new token-ring products. Membership is open to all users and vendors.
3Com Corporation, 3165 Kifer Road, Santa Clara, CA 95052-8145; 408/562-6400
CIRCLE 308 ON READER SERVICE CARD
Madge Networks Ltd., U.S. Affiliate, 534 Salem Avenue SW, Roanoke, VA 24016; 703/982-0638
CIRCLE 309 ON READER SERVICE CARD

PERIPHERALS

Two pointing devices, the **FT-1000** light pen and the **PXL-480** Micro Channel light-pen board have been announced by **FTG Data Systems**. Internally, the FT-1000 uses surface-mount technology for smaller size and improved performance and reliability. Jitter, a common problem with light pens, is virtually eliminated with the FT-1000. The FT-1000 uses a push-tip switch; the optics have been upgraded to permit adequate functioning over a wide range of screen intensities. The FT-1000 works well with reds and browns, previously difficult colors for light pens to recognize.

The PXL-480 light-pen interface board extends light-pen support to Micro Channel machines. The PXL-480 fetches and processes light-pen location data at resolutions as high as 1,024-by-768 pixels. The board comes with light-pen driver software, including a driver for Microsoft Windows that enables every application that runs under Windows to be a light-pen application. FT-1000, $249; PXL-480, $179.
FTG Data Systems, 10801 Dale Street, Suite J-2, Stanton, CA 90680; 800/962-3900; 714/995-3900
CIRCLE 315 ON READER SERVICE CARD

The **Scanmaster II** from **Howtek** is a high-resolution, digital color scanner that scans an image and converts it to digital data that can then be sent over a general-purpose interface bus (GPIB) for display and storage on an image-capturing computer. The input copy can be in the form of line art, text, continuous tone, or half-tone images as large as 8.5-by-11 inches. The Scanmaster II employs a single charge-coupled device (CCD) sensor and all electronic red-green-blue (RGB) color separation methods to digitize full-color and black-and-white images. The platen remains stationary while the CCD sensor and fluorescent lamp assembly moves by the image in steps. Each step corresponds to one scanned line. The Scanmaster II has fixed scanning rates of 75, 100, 150, 200, and 300 dots per inch (dpi) or a continuous resolution of between 30 and 300 dpi. Scanmaster II alone, $4,995; Scan-It software and GPIB interface, $6,195.
Howtek Inc., 21 Park Avenue, Hudson, NH 03051; 603/882-5200
CIRCLE 319 ON READER SERVICE CARD

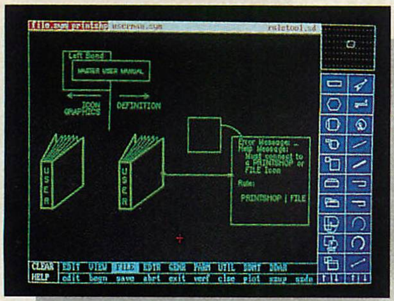
Two members of **Western Automation**'s RAMSTOR product line, **RAMSTOR 4250** (dual port, half height), and **RAMSTOR 5250** (dual port, full height) are high-speed, 5.25-inch, SCSI-compatible RAM disks. The standard interface, form factor, and power requirements of RAMSTOR disks allow them to be used as replacements for conventional SCSI disk drives. Emulating the command set of a disk drive, RAMSTOR disks support the SCSI ANSI standard and the SCSI common command set.

Although similar in operation, RAMSTOR disks outperform conventional disk drives in speed, reliability, and environmental tolerance. Using high-speed, high-density, dynamic RAM (DRAM) chips, RAMSTOR products eliminate the seek, latency, and electromechanical delays associated with conventional disk drives, allowing RAMSTOR disks to deliver average access times of less than 0.5 ms and a maximum sustained transfer rate of 5MB per second. The dual-port version permits two initiators to access the dual-port RAMSTOR without sharing the same SCSI bus. When two controllers simultaneously attempt to access the storage medium, the dual-port RAMSTOR multitasks several of the SCSI bus phases.

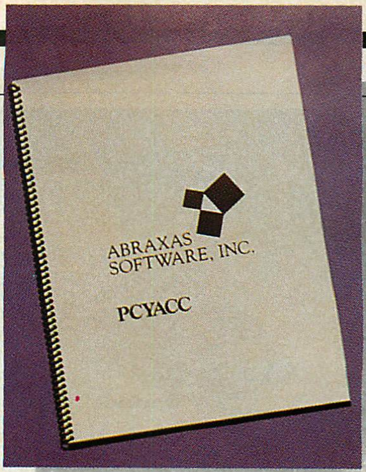
RAMSTOR 4250 with 8MB of RAM (no battery backup), $7,195; with 24MB of RAM (no battery backup), $17,195; RAMSTOR 5250 with 8MB of RAM (with battery backup), $7,895; 8MB of RAM (no battery backup), $7,195; 72MB of RAM (no battery backup), $47,195.
Western Automation, 1700 N. 55th Street, Boulder, CO 80301; 800/227-4637; 303/449-6400
CIRCLE 318 ON READER SERVICE CARD

SOFTWARE DEVELOPMENT

Object/1 from **Micro Data Base Systems** (mdbs) is an advanced development tool for creating applications under the graphics user interface (GUI) of the OS/2 Presentation Manager. Object/1, using object-oriented programming techniques, includes a forms painter, a comprehensive database interface, and CASE tools such as a source-level debugger and system browser. Object/1's interface (to many popular data managers) allows develop-



SYLVA Foundry icon-building screen from CADWARE

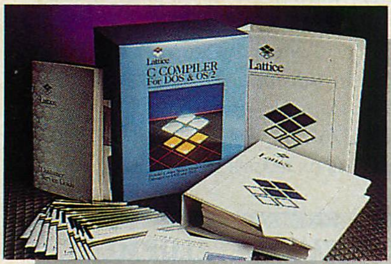


Abraxas's OS/2 CASE tool PCYACC/2

ers to access multiple packages at the Structured Query Language (SQL) level without having to know the individual nuances of each.

The product includes source code, which can be freely altered to extend or limit its capabilities. Hundreds of classes, methods, and objects are included for application development. Object/1 runs on 286 or 386 machines equipped with 4MB of RAM. Prices range from $800 to $1,000.
Micro Data Base Systems Inc., Two Executive Drive, P.O. Box 248, Lafayette, IN 47902-0248; 800/344-5832; 317/463 -2581
CIRCLE 327 ON READER SERVICE CARD

Lattice has announced **version 3.4** of **Lattice C** for DOS and OS/2; it includes CodeProbe, a full-screen, source-level debugger. CodeProbe operates under DOS or OS/2 in real mode. Special support is provided for debugging family-mode programs that use the OS/2 .EXE format, but that run under DOS. Lattice C 3.4 also features



Lattice C 3.4 for DOS and OS/2

an integrated editor, linker, and librarian. The product contains enhancements to the compiler and libraries and performance improvements in floating-point operation and in the large memory model. $450.
Lattice Inc., 2500 South Highland Avenue, Lombard, IL 60148; 800/533-3577; 312/916-1600
CIRCLE 323 ON READER SERVICE CARD

Customization and integration capabilities for the **SYLVA Foundry** are available from **CADWARE**. SYLVA Foundry is a PC-based workbench that enables users to structure their own CASE tools, methods, techniques, and environments. It contains tools for methodology guidance and control, technique creation, technique modification, open-architecture interface with other tools (integrated programming support environment), and diagram generation from external data. The additions to SYLVA Foundry make it easier for users to embed invisible text and to integrate their own trigger programs.

CADWARE's patented RULE TOOL technology allows customer-supplied tools to be seamlessly accessed or driven by the editor through the creation of modeling objects and the local and global rules that govern them.

Once users create modeling objects, they can store them in technique-specific ICON DRUMS for later use in creating system models. A diagram editor, which users can integrate into their own programs, provides a rule-based drawing capability through an intuitive interface for both technique creation and model building. $8,500.
CADWARE Inc., 50 Fitch Street, New Haven, CT 06515; 800/223-9273; 203/397-2908
CIRCLE 320 ON READER SERVICE CARD

An enhanced version of **Abraxas Software**'s OS/2 CASE tool, **PCYACC/2**, has been announced. **Version 2.0** of the program generator automatically generates ANSI C source code for building assemblers, compilers, browsers, page-description languages, language translators, syntax-directed editors, and query languages for OS/2. PCYACC/2 is designed to generate ANSI C source code optimized for Microsoft and Lattice OS/2 compilers. The generated source code is then compiled to generate the final product. Runtime library and example sources are provided as application skeletons for new programs. Features of PCYACC/2 include a code-execution engine to display graphics on a PS/2 screen, the ability to generate code for very large grammars, a quick syntax-analysis feature for grammar implementation, and error-recovery support for target products. $395.
Abraxas Software Inc., 7033 S.W. Macadam Avenue, Portland, OR 97219; 503/244-5253
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A memory-resident add-on utility for Borland's Turbo C, which has more than 400 Turbo C functions, is available from **Computer Ties**. By attaching its own special menu to Turbo C's main

VIZIT! Turbo C add-on from Computer Ties

menu, **VIZIT!** can find the right C routine for the task without making the user leave the keyboard. Easy searches are achieved by using category, last used, and wild-card search. An auto-insert feature types the function into the user's program. A C language quick-reference is included. $49.95.
Computer Ties, 4948 Thunderhead, El Sobrante, CA 94803; 415/223-6944
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DataEase International's stand-alone, PC-based, data-analysis tool, **CrossView**, works logically by identifying key patterns in large volumes of data, allowing users to examine quickly the information in those patterns and make decisions based on it. CrossView allows

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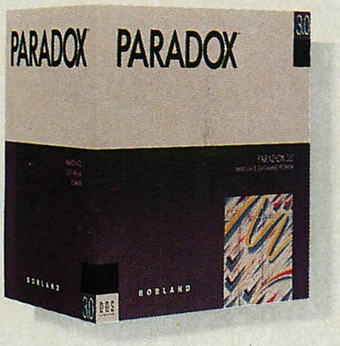

Borland's Paradox 3.0 data-management system

CrossView data-analysis tool from DataEase

an unlimited, multidimensional view of data in ASCII format and identifies key patterns in data without a predefined report. Users can consider as many variables as they want to access their required information. The user first collects data from micro, mini, or mainframe computer programs; CrossView then converts the data into an array of unique values by compressing them with a transformation module.

Once the data are prepared, the CrossView analysis module permits users to view and analyze any cross-section of the array by identifying cells, rows, columns, pages, and hyperpages from the data elements. Users can revise the view with a few keystrokes to explore further the relationships and patterns in data. Information accessed through CrossView can be output or exported to any device or program that accepts standard ASCII files. Single-user version, $2,000; multiuser server pack (accommodates six users), $3,000; workstation pack (three additional users), $1,000.
DataEase International Inc., Seven Cambridge Drive, Trumbull, CT 06611; 800/243-5123; 203/374-8000
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DATABASE MANAGEMENT

A revision of **Borland International**'s data manager, **Paradox**, has been made. **Version 3.0** includes query-by-example (QBE) enhancements, such as an inclusion operator that allows the user to perform an outer join of two or more tables in a query; set operations that include new operators for greater expressiveness and analytical ability; and more control over sort ordering of answer tables. Relational enhancements include multitable forms and reports, multirecord forms with scrolling regions, linked tables in forms, and referential integrity.

Paradox 3.0 has a built-in presentation graphics capability for creating pie charts, line graphs, bar graphs, and *x-y* graphs with full-color customization. It also has additional PAL (Paradox's programming language) commands that provide greater screen control. All of the new features of Paradox 3.0 work in a multiuser LAN. (For more details on Paradox 3.0, see "In Front of the Server," Herb Edelstein, this issue, p. 62, and "Paradox Made Better," New Directions, Will Fastie, February 1989, p. 21.) $725; upgrade from 1.0, 1.1, 2.0, Paradox 386, or Paradox OS/2, $175; from LAN Pack to universal, $350.
Borland International, 1800 Green Hills Road, Scotts Valley, CA 95066; 408/438-8400
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Verity is building software bridges to integrate **TOPIC**, its full-text retrieval software, with leading relational data managers. TOPIC provides the ability to store and retrieve free-text data from applications integrated with Informix, Ingres, Oracle, and Sybase relational databases. Complementing the row- and column-structured retrieval capabilities of Structured Query Language (SQL), TOPIC integrates text- and record-oriented data in unified applications. TOPIC is based on concept retrieval; concepts are defined as topics using a hierarchical outline. Rather than composing queries using a complex Boolean query language, users select or build a topic that describes the concept the user is interested in retrieving. TOPIC also searches by ranking documents in order of relevance, providing access to the most meaningful and valuable information first.

TOPIC is available as a stand-alone, multiuser system or in a network configuration. It can run on the same computer as the data manager or on a different computer and communicate over the network. Optional data-manager interface, $2,500. On a network, TOPIC consists of server software priced from $9,000 to $66,000, depending on processor class. Client retrieval engines, $695 per DOS-based computer; $2,500 per Sun workstation.
Verity Inc., 1550 Plymouth Street, Mountain View, CA 94043; 415/960-7600
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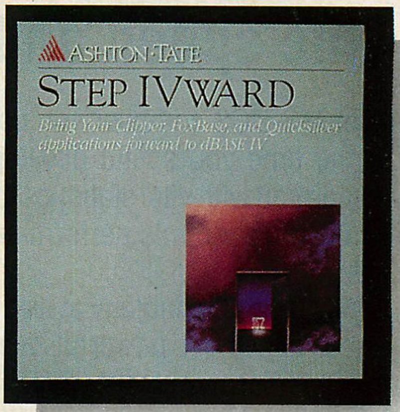
A conversion program from **Ashton-Tate** allows developers with Nantucket's Clipper, Fox Software's FOXBASE, and WordTech Systems' Quicksilver



Step IVward conversion program from Ashton-Tate

applications to convert those applications to DBASE IV without rewriting large amounts of code. **Step IVward**, a menu-driven, stand-alone DBASE IV utility, translates most of the functionality in these products and includes file-tree processing, in-code commenting, and full printing capabilities. $89.95.
Ashton-Tate Corporation, 20101 Hamilton Avenue, Torrance, CA 90502-1319; 800/437-4329; 213/329-8000
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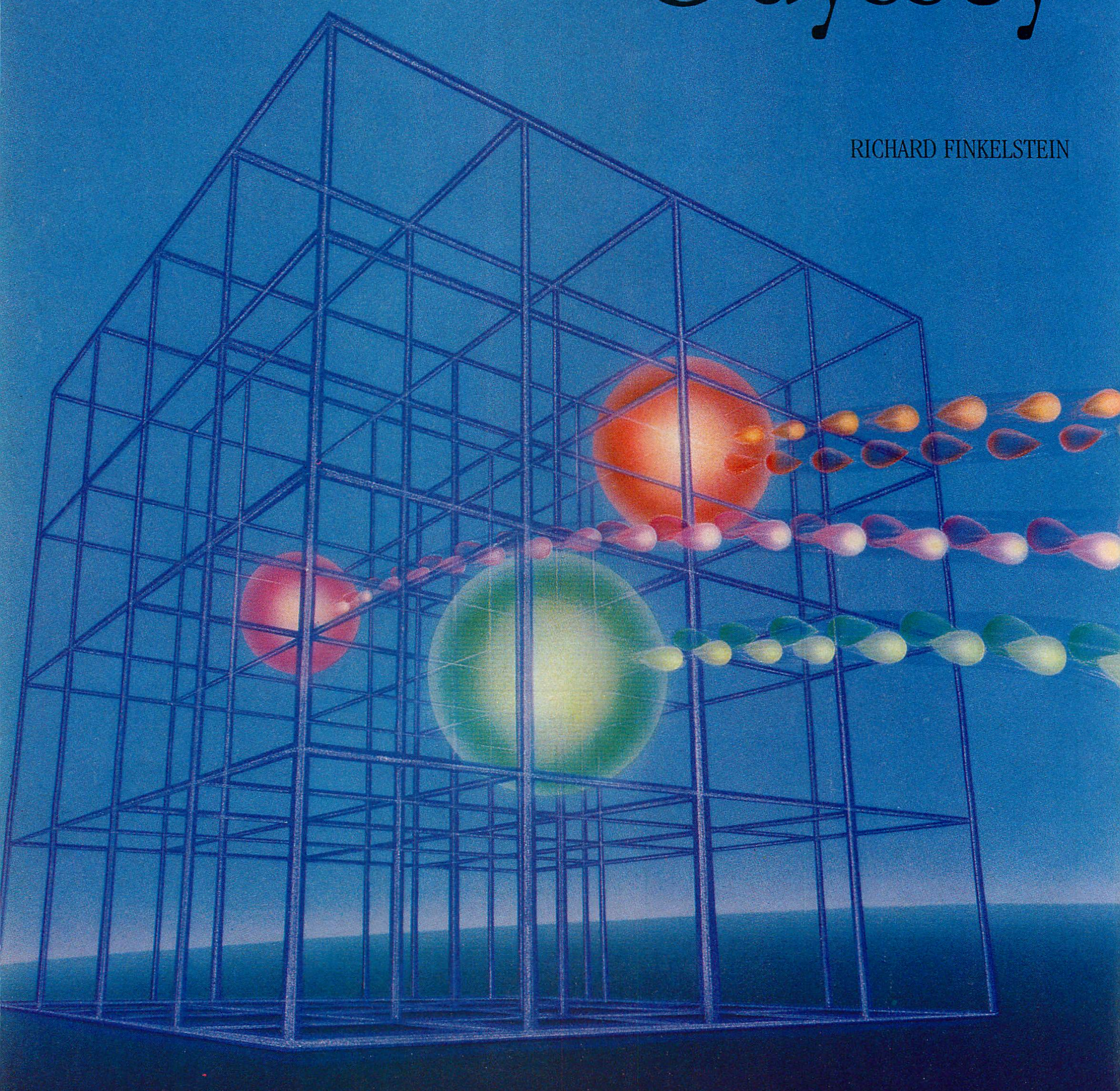
A Database Server Odyssey

RICHARD FINKELSTEIN



The future of data management is close by. PCs soon will be infused with the powerful data-sharing capabilities formerly limited to mainframes. Key to this future is the SQL-based database server.

The new buzzwords in PC data management are "client-server database management." Vendors promise revolutionary new database management to place the PC into mainstream corporate computing. Is the database server really daring new technology or is it an old local area network (LAN) concept revitalized? Is it hyperbole or the wave of the future?

Dishing up benefits depends on server architecture, which is illustrated here using five currently available Structured Query Language (SQL) database servers that run under DOS or OS/2. The servers reviewed are the Ashton-Tate/Microsoft SQL Server Network Developers' Kit, developed jointly by Ashton-Tate, Microsoft, and Sybase; Gupta Technologies' SQLBase version 3.5; Novell's NetWare SQL version 1.0 Beta; Oracle Corporation's ORACLE Server version 5.1 Beta; and XDB Systems' XDB-Server 2.2. The second article in this cover suite (page 62) focuses on database-server front ends, the user interfaces and application-development tools that allow applications to communicate with servers.

A database server is a multiuser data-management engine that centralizes search, retrieval, and processing data requested by an application on a workstation (client). Servers reduce network traffic by coordinating multiple access to a database and returning only requested data to the application, and they incorporate mainframe-quality data integrity and security features.

ILLUSTRATION • DOUG CHEZEM

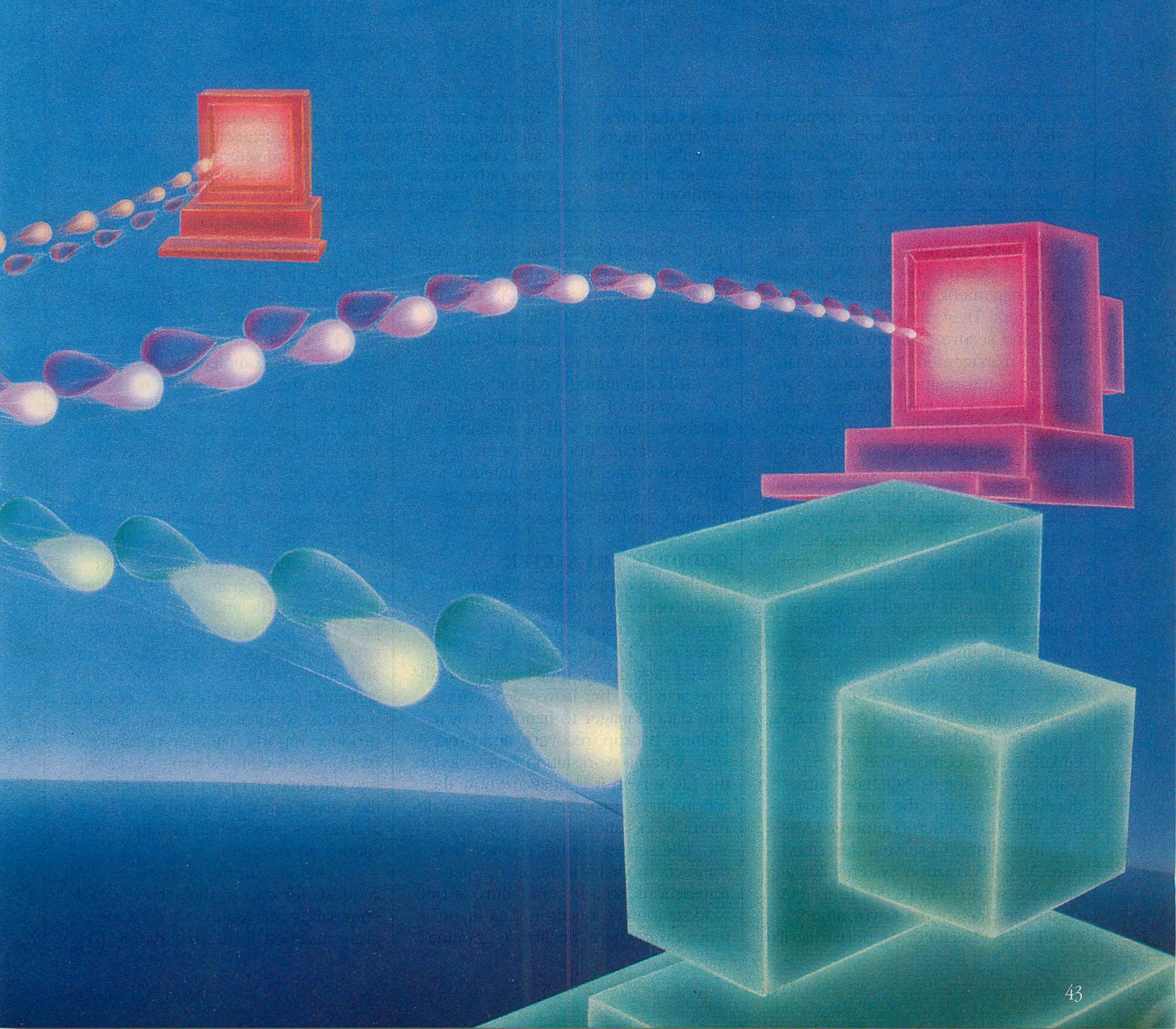
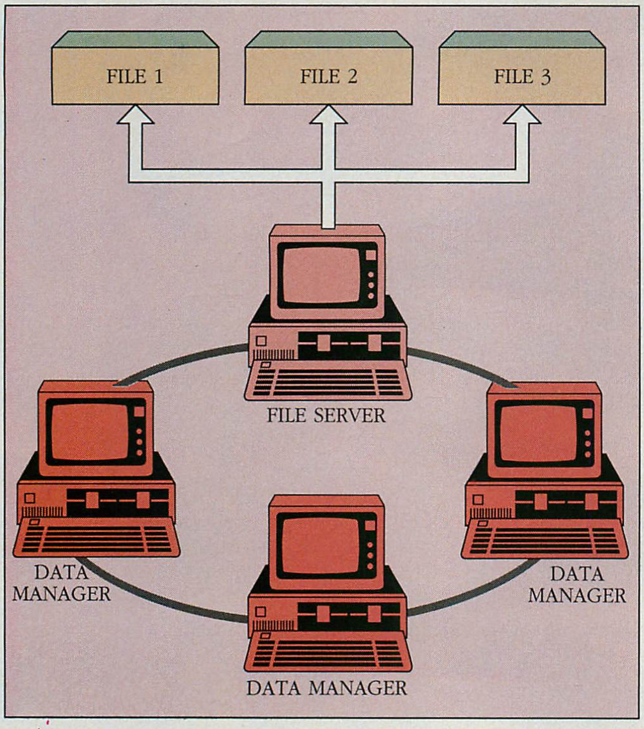
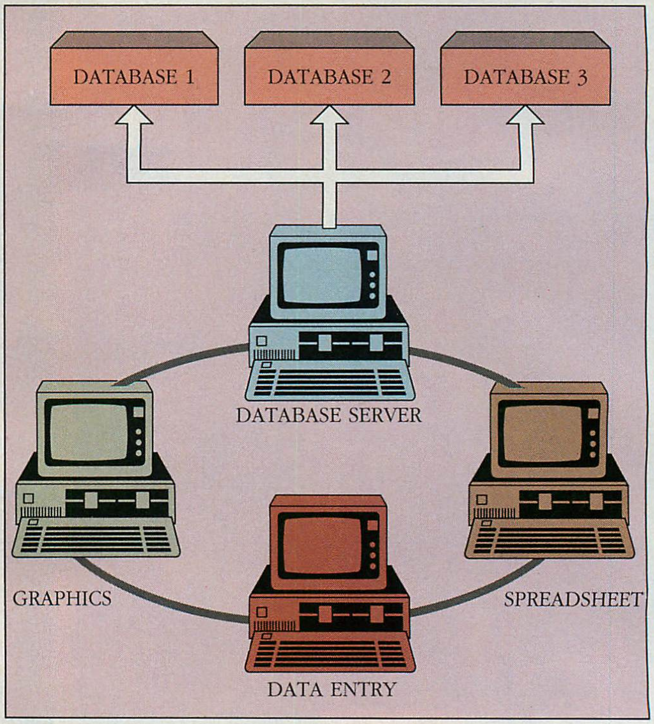


FIGURE 1: ***File Servers***



In file servers, one node in the network accesses data files, while other nodes run both applications and data managers, which lock tables and request data. Network traffic jams occur as lock requests are sent to the server and all records in the table are returned to the requesting application.

FIGURE 2: ***Database Servers***



Database servers centralize all data-management activities, including coordination of locking, maintaining data integrity and consistency, and accessing and returning to an application only records requested. Network traffic is reduced and both the integrity and consistency of data are assured.

By reducing network traffic, database servers can boost PC LAN and data-management performance above file servers. They can provide a functional and secure platform on the PC for data-management operations that, until now, information managers have considered too complex, large, or critical for the PC. Finally, because client machines can be PC/XTs, PC/ATs, PS/2s, and compatibles without the need for adding memory or upgrading, database servers allow widespread and economical data sharing for all businesses.

While client-server database technology is new and revolutionary to the PC community, it is well-founded in the mainframe world, where multiuser functionality first became important.

Most servers for PCs are built on SQL, widely accepted as a standard database query language (see "Lingua Franca for Databases," Richard Finkelstein, December 1987, p. 52). Gupta Technologies' SQLBase, introduced in 1986, was the first SQL database server for microcomputer LANs.

In addition to servers described here, VIA Information Systems has a database server, VIA/HOST, in its VIA/Distributed Relational Environment (VIA/DRE). VIA/HOST supports distributed database processing—transparent data sharing across short or long distances among nodes in a LAN or wide area network (WAN). The product's SQL version was not available in time to be included in this article.

IBM has announced that the multiuser version of OS/2 Extended Edition Database Manager will be available as a database server, but has not given an availability date. It will be integral to IBM's LAN strategy and its larger distributed database-server technology.

GOODBYE, FILE SERVER

In file-server topologies, data managers reside on each workstation, and the shared data reside on the file server (see figure 1). File servers act as shared disk drives; they cannot coordinate activities, but leave each workstation data manager to handle its own locking, backup, recovery, and processing. When a workstation sets locks on the file server, it is unaware how the action affects programs running on different workstations.

File servers cannot recover lost transactions or back out incomplete transactions, so a system failure at one workstation can result in data inconsistency everywhere. Security—granting and revoking privileges—is not centralized because file servers cannot relate tables and databases and do not have central data dictionaries.

They suffer in performance by sending only complete tables to workstations. The data manager must then filter out needed records. File servers also have high overhead in moving data tables, indexes, and lock requests between file server and workstation.

A database server on a central PC addresses all the problems of file servers. The database server (see figure 2) controls access to the database and monitors all programs at workstations. It manages table and row locking, database backup and recovery, data integrity, security, transaction management, and other multiuser events automatically and transparently. This frees client machines to interact with users and produce reports. The system catalog (with system tables storing all descriptive information) is in one location so the server can track all tables, indexes, and access paths while multiple applications access them.

Programs on the workstation send requests for data to the server as SQL commands relayed by a redirector program installed at the workstation. The

TABLE 1: *System Requirements for Database Servers*

	ASHTON-TATE/ MICROSOFT	GUPTA TECHNOLOGIES	NOVELL	ORACLE CORPORATION	XDB SYSTEMS
PRODUCT	SQL Server	SQLBase	NetWare SQL	ORACLE Server	XDB-Server
System	PC/AT, PS/2	PC/AT	PC/AT, PS/2	PC/AT, PS/2	PC/AT, PS/2
Operating system	OS/2	DOS 3.1+, OS/2	NetWare	OS/2 1.0+	DOS 3.1+
Hard disk (minimum)	30MB	10MB	10MB	10MB[a]	10MB
RAM (minimum)	6MB	640KB	512KB	640KB, 896KB extended	640KB
Network support	MS LAN Manager 1.0	NETBIOS compatible	NetWare	NETBIOS compatible	NETBIOS compatible

[a] *4.5MB for server only.*

The first database servers entering the PC marketplace run on 80286- or 80386-based computers, largely under OS/2, DOS, or both. Enough variety exists to allow consumers to select a server that runs on computers currently in their workplace.

server processes them, retrieves only the rows requested, and sends them to the client. A program can update tables by sending SQL UPDATE to the server.

CHOOSING A SERVER

Building multiuser data-management capabilities into a non-database server system would cost hundreds of thousands of dollars. The task also is difficult, which explains why only a handful of database servers are available.

Many factors influence choice of a server, including availability of front ends. Some vendors offer servers and front ends as a package; other vendors are positioning their front ends to work with specific servers. Buyers need to look for servers and front ends that are compatible.

Most front-end vendors, such as Ashton-Tate and Borland, are making application development for the server architecture almost identical to development on their stand-alone data managers. Front ends support direct entry of SQL as well as generate SQL from their own query languages or query-by-example (QBE) facilities.

Other factors to consider are operating-system and resource requirements, installation, SQL support, concurrency (shared use of data) control, recovery mechanisms, security, performance, and connectivity to data managers on mainframes and minis.

The hardware and operating-environment requirements of each system vary (see table 1). The server should be an 80286- or 80386-based machine; clients can be any type of PC, depending on application needs.

ORACLE Server and SQL Server run only under OS/2, while XDB-Server requires DOS. SQLBase runs under either DOS or OS/2, and NetWare SQL requires the NetWare operating system.

No database server is easy to install or operate, although some are easier than others. None demands a full-time administrator, but someone must take on part-time administration responsibilities. Administrators must know backup and recovery, performance tuning, hardware-capacity planning, database design and security, and physical database implementation.

SQLBase. SQLBase is simple to install. The administrator loads the executable module and supporting files on the server, then initializes a database using the INIT procedure. A configuration file lists all databases on the network and their location, maximum number of workstations, number of 1KB cache (buffer) pages, and number of users, cursors, locks, and transactions the server allows at one time.

An interactive environment, SQLTalk, aids in querying databases and saving precompiled SQL statements. Commands set the SQLTalk environment; connect multiple databases and cursors; write reports; manage backup, recovery, and journaling (logging all changes to a database); import and export data; store precompiled SQL statements; and prototype applications.

A Server Status screen displays client-node numbers and active databases; Process Activity shows connected databases and SQL statements being processed; and System Activity provides technical information about the server for technical support.

NetWare SQL. A simple setup program installs NetWare SQL and sets the system configuration option. Parameters include maximum message length, maximum buffer size, and number of processes. The Install option copies NetWare SQL programs onto the server, and the administrator copies workstation programs onto each workstation.

The NetWare SQL administration console displays the number of active workstations and active processes and allows the administrator to release resources used by a workstation.

XDB-Server. XDB-Server has a straightforward installation, which prompts for server-menu colors, paths, server name, and NETBIOS interrupts. The configuration procedure prompts for parameters, including number of users; maximum number of open databases, queries, and files; maximum sort memory size; and maximum lock table size. Administrators can set buffer size at workstations, each with its own install procedure to load the XDB workstation and redirector programs.

A user-activity screen lists logged-on users, their locking level, and whether they have an open query. The administrator can delete a user from the system if a workstation fails.

XDB-Server has low memory requirements (640KB) and supports 20 users under DOS and more than 100 on OS/2. These numbers, however, depend on application performance requirements. System-administration utilities, such as SRVCONFIG, should be loaded into a secure directory via network security constraints. Otherwise, anyone with server access can reset system parameters.

ORACLE Server. ORACLE Server was developed for DEC VAX and high-end Unix systems, and its heritage comes through loud and clear: it requires complex management by a knowledgeable administrator. Installation is difficult to follow when the developer overrides the default partitions and space definitions.

The administrator must monitor default allocations. If the database runs out of space, ORACLE Server crashes, and the administrator must recover the

TABLE 2: *SQL Commands*

	ASHTON-TATE/ MICROSOFT	GUPTA TECHNOLOGIES	NOVELL	ORACLE CORPORATION	XDB SYSTEMS
PRODUCT	SQL Server	SQLBase	NetWare SQL	ORACLE Server	XDB-Server
DATA DEFINITION					
ALTER TABLE ADD	●	●	●	●	●
DELETE (DROP)	○	●	●	○	●
MODIFY	○	●	●	●	●
COMMENT ON	○	●	○	●	●
CREATE INDEX	●	●	●	●	●
UNIQUE	●	●	○[a]	●	●
CREATE SYNONYM	○	●	○	●	●
CREATE TABLE	●	●	●	●	●
PRIMARY KEY	○[b]	○	●	○	●
CREATE VIEW	●	●	●	●	●
WITH CHECK OPTION	○	●	○	●	●
DROP INDEX	●	●	●[c]	●	●
DROP TABLE/VIEW	●	●	●	●	●
NULL/NOT NULL	●	●	○	●	●
WITH DEFAULT	○	○	○	○	●
DATA MANIPULATION					
DELETE	●	●	●	●	●
Subquery	●	●	●	●	●
GROUP BY	●	●	●	●	●
INSERT	●	●	●	●	●
Subquery	●	●	●	●	●
ORDER BY	●	●	●	●	●
SELECT	●	●	●	●	●
ALL	○	○	○	●	●
ANY	●	●	○	●	●
AVG ( )	●	●	●	●	●
BETWEEN	●	●	○	●	●
Columns	●	●	●	●	●
COUNT ( )	●	●	●	●	●
COUNT (*)	●	●	●	●	●
DISTINCT	●	●	●	●	●
EXISTS	●	●	●	●	●

database and add space. Even experienced database administrators will find the product dizzying.

SQL Server. SQL Server's setup program installs the server, utilities, and programming tools as either a stand-alone data manager or a server. The program, which gives instructions with prompts, issues an error message if Microsoft's LAN Manager (which has named pipes) is not already installed.

The menu- and dialog-driven Server Administration Facility (SAF) queries a database and examines results from any workstation. To manage the server and its users, the administrator uses SAF with SQL queries and system procedures (such as **sp_helpuser** and **sp_configure**). Documentation guides setting up user accounts, groups, and passwords using the SAF Admin option; displaying user information using the **sp_helpuser** procedure; creating backup and recovery procedures; configuring resources to maximize performance; and building bulk-loading procedures.

A wealth of tuning options is available via the **sp_configure** system procedure, including maximum number of connections, memory available for procedure and data caches (to store most recently used procedures and data), and fill factor (to specify when SQL Server needs to split a page when creating a new index on data).

SQL Server can be daunting, but all functions are useful in large-volume, on-line transaction systems, such as order-entry applications.

FULL-BODIED SQL

All these database servers support full versions of SQL, which allow applications to talk to other applications and to mainframe data managers, such as IBM's DATABASE 2 (DB2) and SQL/Data Services (SQL/DS). Most model their SQL after IBM's DB2, which supports date and time data types, DROP and REVOKE, and the UNION relational operator, none of which are in the existing ANSI standard. Table 2 lists conformance to IBM SQL commands and table 3 lists vendor extensions for each server. Staying close to standards means the system has greater portability and connectivity, but extensions can save time, reduce programming effort, and increase power.

For users wanting to stick close to IBM, SQLBase, NetWare SQL, and XDB-Server are good choices. Users who desire extensions will find SQL Server and ORACLE Server robust. Users can ignore extensions to ensure future compatibility with IBM or ANSI SQL.

NetWare SQL and SQLBase. NetWare SQL supports IBM SQL with no extensions. SQLBase has a few extensions: date and time, string-handling (such as Substring and Find String), and math functions.

	ASHTON-TATE/ MICROSOFT	GUPTA TECHNOLOGIES	NOVELL	ORACLE CORPORATION	XDB SYSTEMS
DATA MANIPULATION *(continued)*					
Expressions	●	●	●	●	●
ALL	○	●	○	●	●
FROM	●	●	●	●	●
HAVING	●	●	●	●	●
IN	●	●	●	●	●
IS NULL	●	●	○	●	●
LIKE	●	●	●	●	●
MAX ( )	●	●	●	●	●
MIN ( )	●	●	●	●	●
NOT	●	●	●	●	●
SOME	○	○	○	○	○
Subquery	●	●	●	●	●
Correlated subquery	●	●	●	●	●
Outer join[d]	●	●	●	●	●
SUM ( )	●	●	●	●	●
WHERE	●	●	●	●	●
UNION	○	●	●	●	●
UPDATE	●	●	●	●	●
Subquery	●	●	●	●	●
DATA CONTROL					
GRANT	●	●	●	●	●
WITH GRANT OPTION	○	●	○	●	○
REVOKE	●	●	●	●	●
TRANSACTION CONTROL					
COMMIT WORK	●	●	●	●	●
ROLLBACK WORK	●	●	●	●	●

● = Yes ○ = No

[a] Unique indexes can be specified in the CREATE TABLE command using the WITH INDEX UNIQUE clause. The DROP INDEX command cannot be used on these indexes.

[b] Can be enforced through stored catalog procedures.
[c] Can only drop indexes with the CREATE INDEX command.
[d] Outer joins are limited to two tables.

The five database servers reviewed here closely conform to IBM SAA SQL. With only a few exceptions, developers writing applications that use high-level language interfaces can use the same SQL data-manipulation commands with all five servers.

XDB-Server. XDB-Server incorporates IBM's SQL error codes so COBOL programmers can use XDB-Server as a development workstation for DB2 applications. It is the only one of these servers that supports referential integrity and other integrity rules in its Data Definition Language (DDL), which consists of SQL statements defining objects such as tables, views, and indexes. However, this is not as full featured as DB2's, which has CASCADE capabilities (to delete rows that depend on a deleted row) and SET NULL capabilities (to set foreign keys to NULL). XDB-Server also uses the ALTER statement instead of DB2's CREATE.

XDB-Server implements referential integrity with several keys, which restructure an existing table or add integrity constraints. PRIMARY KEY and UNIQUE KEY clauses enforce uniqueness constraints on single or composite fields and require NOT NULL specifications (fields must be given a value). FOREIGN KEY clauses enforce referential integrity on inserts and updates.

Referential integrity enforces business rules, such as preventing an invoice without a customer and a payroll transaction without an employee. Developers can implement rules, but putting them in the catalog eases maintenance and provides consistency.

The CHECK option in ALTER TABLE stores user-defined conditions checked against each row inserted or updated. If a row does not meet the conditions, it cannot be inserted or updated and XDB-Server produces an error message. The following SQL statement enforces the condition that articles cannot exceed 10 pages:

ALTER TABLE articles CHECK pages ≤ 10

Users cannot embed SQL in CHECK operations or put validation rules in the catalog.

Special commands for recursive queries can find all parts of a whole; for example, all parts in an assembly or all employees reporting to one manager. XDB-Server's PREVIOUS clause in the SELECT command generates a relational table that lists all parts for an assembly. Users can specify which level to stop the explosion—for example, LEVEL=2 specifies a second-level subassembly, and the BOTTOM clause specifies the lowest level.

SQL Server. SQL Server has catalog-controlled data integrity, but not within the DDL (the CREATE or ALTER TABLE commands). It uses triggers defined with the powerful TRANSACT-SQL extension, which includes flow-control key words, such as IF . . . THEN . . . ELSE, GOTO, and numerous variable-assignment and manipulation commands. TRANSACT-SQL can build routines supporting referential integrity and user-defined rules. Stored in the

TABLE 3: *SQL Extensions*

	ASHTON-TATE/ MICROSOFT	GUPTA TECHNOLOGIES	NOVELL	ORACLE CORPORATION	XDB SYSTEMS
PRODUCT	SQL Server	SQLBase	NetWare SQL	ORACLE Server	XDB-Server
TRANSACTION CONTROL					
Begin/start transaction	●	○	●	○	○
Holdlock	●	○	○	○	○
Lock table	○	○	○	●	●
Set isolation level	○	●	○	○	●
Unlock table	○	○	○	○	●
OPERATIONS					
Compute	●	○	○	○	○
Intersect	○	○	○	●	○
Minus	○	○	○	●	○
Recursive	○	○	○	●	●
Subquery in Update Where clause	●	○	○	●	○
Subquery as any expression	●	○	○	○	○
IF condition	●	●	○	○	○
ELSE action	●	○	○	○	○
MATHEMATICAL FUNCTIONS					
Absolute	●	○	○	●	●
Ceiling/floor	●	○	○	●	○
Degrees	●	○	○	○	○
Exponential	●	○	○	○	●
Logarithmic	●	○	○	○	●
Pi	●	○	○	○	○
Modulo	○	○	○	●	○
Power	●	○	○	●	●
Radians	●	○	○	○	○
Random	●	○	○	○	○
Round	●	○	○	●	○
Sign	●	○	○	●	○
Sqrt	●	○	○	●	●
Trigonometric	●	○	○	○	○
Truncate	○	○	○	●	○
CHARACTER FUNCTIONS					
ASCII value	●	○	○	●	○
Character value	●	●	○	●	○
Concatenate	●	●	○	●	●
Exact match	○	●	○	●	○
Initial capital	○	●	○	●	○
Find string	●	●	○	●	○
Length	●	●	○	●	●
Lowercase	●	●	○	●	●
Pad left/right	●	○	○	●	●
Left/right trim	●	●	○	●	●
Repeat string	●	●	○	○	○
Replace string	○	●	○	○	○
Stuff a string	●	○	○	○	○
Substring	●	●	○	●	●
Translate	○	○	○	●	○
Uppercase	●	●	○	●	●

	ASHTON-TATE/ MICROSOFT	GUPTA TECHNOLOGIES	NOVELL	ORACLE CORPORATION	XDB SYSTEMS
STATISTICAL FUNCTIONS					
Standard deviation	○	○	○	●	●
Variance	○	○	○	●	●
DATE FUNCTIONS					
Get current date	●	●	●	●	●
Add months to day	○	○	○	●	○
Last day of month	○	○	○	●	○
Months between	○	○	○	●	○
Time-zone conversion	○	○	○	●	○
Next day of week	○	○	○	●	○
Day	●	●	○	○	●
Hour	●	●	○	○	○
Minute	●	●	○	○	○
Second	●	●	○	○	○
Millisecond	●	○	○	○	○
Weekday	●	●	○	○	○
Month	●	●	○	○	●
Quarter	●	●	○	○	○
Year	●	●	○	○	●
Year number	○	●	○	○	○
Week beginning	○	●	○	○	○
Month beginning	○	●	○	○	○
Quarter beginning	○	●	○	○	○
Year beginning	○	●	○	○	○
Convert to date	○	●	○	○	●
Date arithmetic	●	●	●	●	●
MISCELLANEOUS FUNCTIONS					
Decode values	○	●	○	●	○
Null-value default	○	●	○	●	○
Greatest/least value	○	○	○	●	○
DDL					
Alter table					
Primary key	○	○	○	○	●
Foreign key	○	○	○	○	●
Reference	○	○	○	○	●
Restrict	○	○	○	○	●
Create/alter					
Space	●	○	○	●	○
Partition	○	○	○	●	○
Cluster	○	○	○	●	○
Create values/range	●	○	●	○	●
Create clustered					
Indexes	●	○	○	○	○
Tables	○	○	○	●	○
Create triggers/ stored procedures	●	○	○	○	○
DCL					
Create/drop group	○	○	●	○	○

● = *Yes* ○ = *No*

Most vendors of database servers adhere to IBM SQL with extensions that save time and effort in programming. Systems with mainframe roots, such as the SQL Server Network Developers' Kit and ORACLE Server, have extensions concerned with space allocation; all of the five database servers reviewed except NetWare SQL have date, time, character, and math extensions.

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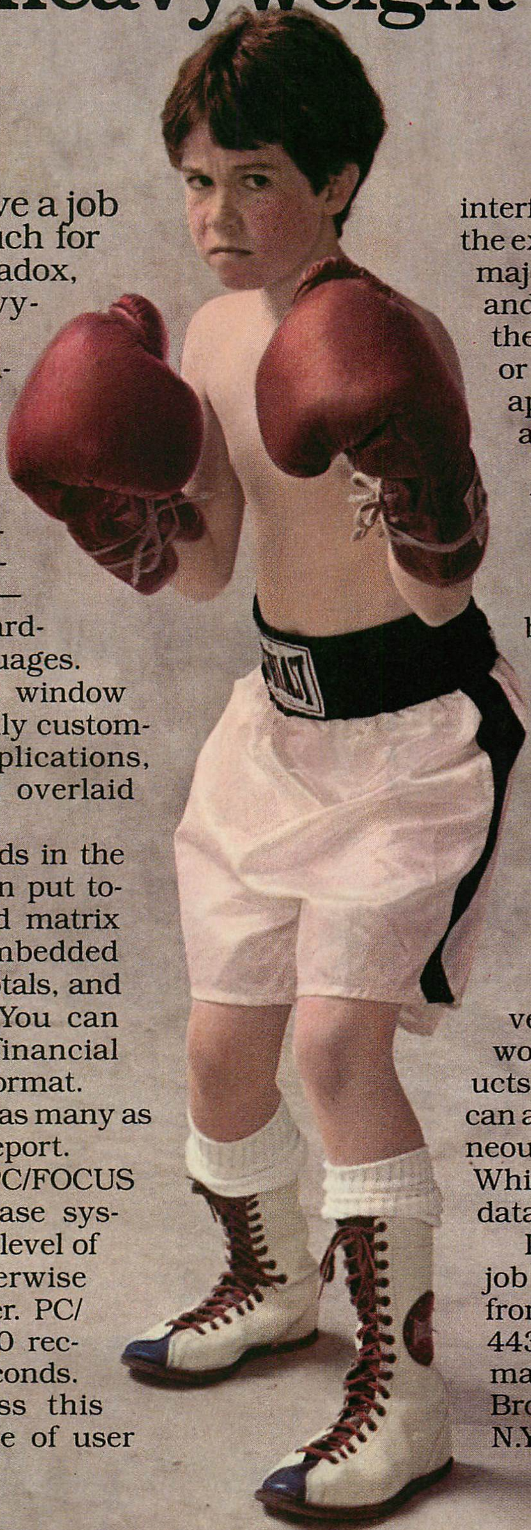

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catalog, triggers are automatically invoked when a table is updated. They can ensure that when a value in a table changes, all occurrences of that value change; can prevent change to a foreign key when the value does not match its primary key; can rollback updates that fail to pass a specified condition; and can check that data fall within domains and ranges or that values do not exceed limits.

Triggers in the catalog are easier to maintain than procedures written in programs and are consistent across all programs, but they execute only at the end of a transaction. A user could spend time entering an order, only to find the transaction cannot be completed. The error should be indicated when the customer number is first entered rather than when the transaction tries to complete.

In addition to triggers, SQL Server has two other data-integrity mechanisms: defaults, which are predefined values that SQL Server inserts into a column when the end user does not enter one; and rules, which specify values accepted into columns.

SQL Server's unique *stored procedures* consist of precompiled TRANSACT-SQL commands stored in one catalog routine called from any program. A stored procedure may read, update, and insert data in one procedure. Stored procedures allow a program to make fewer SQL calls to the database server, decreasing network traffic and program-to-server overhead. Because they are precompiled in the system catalog, performance is improved dramatically.

SQL Server also supports subqueries, which can be used anywhere an expression is allowed as long as a single value is returned. Subqueries allow users to develop powerful queries such as:

```
SELECT salesperson, sales, sales/SELECT
  SUM(sales FROM sales_table)
FROM sales_table
```

This query finds all salespeople, their sales, and percentage of total sales, which is derived by dividing their sales by the result of a subquery that finds the sum of all sales. No other database server can use the subquery as part of the expression. Temporary tables or views must be created to do the same query using other database servers.

A glaring problem with SQL Server is omission of the UNION operation, basic to IBM's SQL, which is essential for merging tables. Ashton-Tate and Microsoft should fill this gaping hole. Users can simulate a UNION with INSERT . . . SELECT commands, but must create and use temporary tables.

ORACLE Server. ORACLE Server has many SQL extensions. For example, users can write a correlated query to update a table based upon a value in another table. The following query updates a new department table with managers from an old department table:

```
UPDATE new_dept_table
SET new_manager = (SELECT
  old_manager from old_dept_table
WHERE old_dept_table.dept_no =
  new_dept_table.dept_no);
```

Only ORACLE Server supports updates with a correlated subquery in the SET clause, which is essential to move data among tables based on key values.

An important function of database servers is automatic locking, which prevents update collisions between transactions.

ORACLE Server also has MINUS and INTERSECTION commands that support the relational difference and intersection operations, avoiding the need for subqueries in these operations. IBM recently introduced the same commands in OS/2 Extended Edition Database Manager's SQL. (For a review of Database Manager, see "OS/2 Meets SQL," Herbert A. Edelstein, February 1989, p. 62.)

ORACLE Server's CONNECT clause in the SELECT command does recursion without the LEVEL or BOTTOM capabilities of XDB. ORACLE Server provides a level identifier so the result table includes the level number of each row in the recursive operation.

The product's triggers are embedded in an application or bound to a field in a data-entry or update form. They do not have the advantages of SQL Server's triggers, which the data manager centrally invokes and controls to maintain referential integrity.

System catalogs. All vendors maintain system catalogs as SQL tables for storing information about tables, indexes, views, columns, and other objects. Developers, end users, and database administrators can retrieve information from system catalogs using SQL commands. They quickly can find out which tables and views are available, which columns are in which tables, and which columns have indexes. Most vendors stay close to IBM and have system tables for tables, columns, indexes, views, synonyms, keys, passwords, and privileges for each database (see table 4). ORACLE Server has system tables for information such as database audit trails, quotas, sessions, and space allocation; SQL Server's system tables include information on stored procedures, messages, and configurations.

SQL Server and ORACLE Server extend the catalog to include physical disk-storage information. ORACLE Server has several catalogs to preserve audit information, while XDB-Server stores recovery information in its SYSDB table. SQL Server stores statistical information about data in application tables, which its optimizer uses to choose the fastest method for retrieving and updating data. The UPDATE STATISTICS command updates statistics on indexes.

NONCOLLISION INSURANCE

An important function of database servers is automatic locking to prevent update collisions between transactions, which can result in lost updates and inconsistent data. In a multiuser environment (where multiple users can simultaneously access the same records), locking should be automatic.

To appreciate the power of database-server locking, you must understand the limits of file-server locking. File-server database systems can implement only *passive* (or optimistic) locking on networks with light transaction volumes. This allows users simultaneously to share records that may be updated. Before a user update, the data manager checks if the record has been changed by another program. If so, the file server rejects the second transaction and sends an error message to the program or operator. Some file servers display updates as they occur.

With file-server locking, operators may enter a transaction only to see it rejected. Flashing changes on-screen can be frustrating; a telephone-order operator might answer a call, look up an item, tell the customer it is available, then see it disappear.

Database servers, on the other hand, can automatically lock entire tables (table level), pages (block level) of 1KB or 2KB (depending on the server), or individual records (record level) because logic is centralized at the server node (see table 5). They ensure consistency by using either share locks,

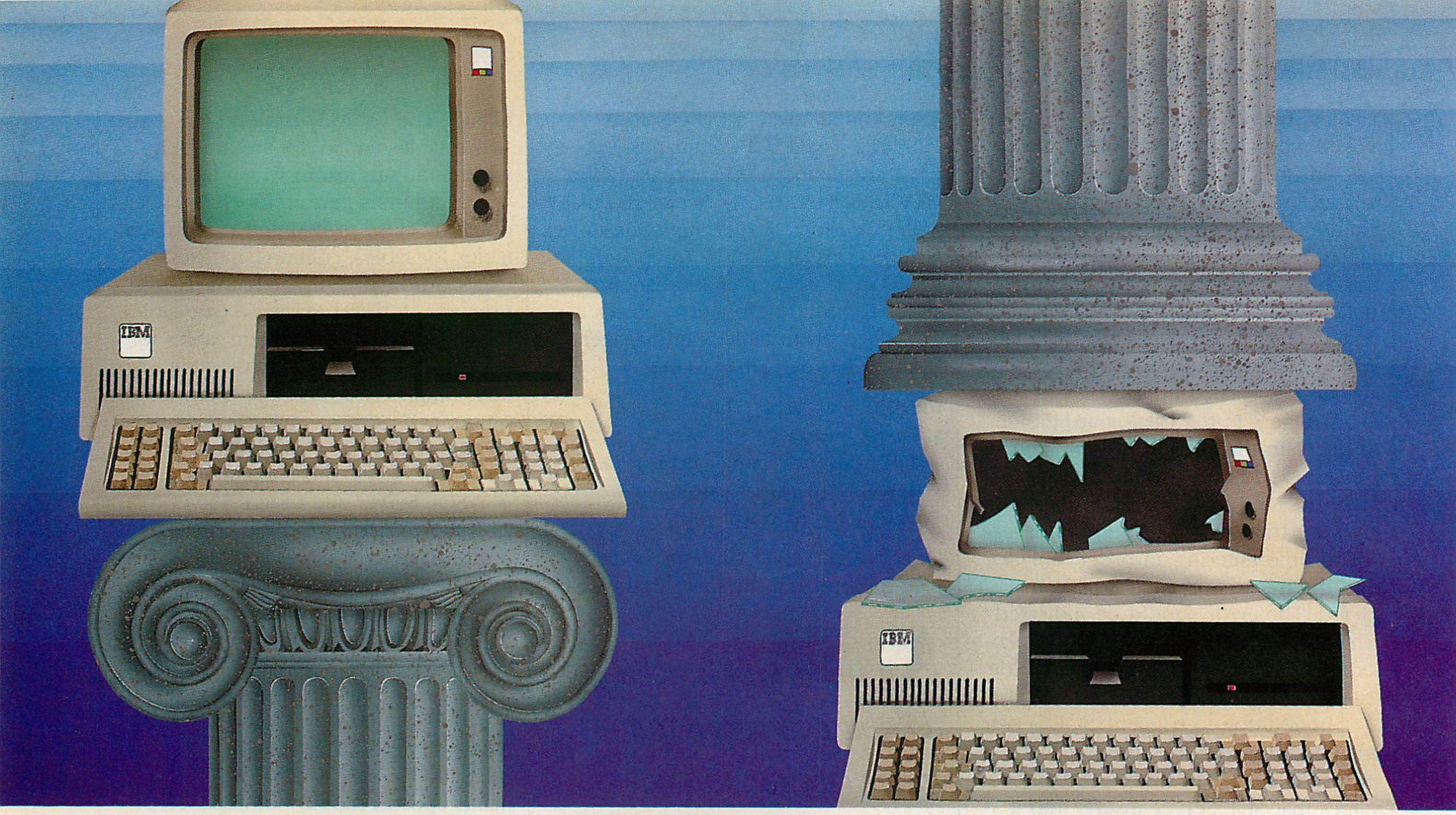

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TABLE 4: ***System Catalogs***

	ASHTON-TATE/ MICROSOFT	GUPTA TECHNOLOGIES	NOVELL	ORACLE CORPORATION	XDB SYSTEMS
Product	SQL Server	SQLBase	NetWare	ORACLE Server	XDB-Server
Tables	Sysobjects	Systables	—	Syscatalog	Systable
Columns	Syscolumns	Syscolumns	FIELD.DDF	Syscolumns	Syscols
Index	Sysindexes	Sysindexes	INDEX.DDF	Sysindexes	Sysindex
Views	—	Sysviews	VIEW.DDF	Sysviews	Sysviews
Synonyms	—	Syssynonyms	—	Synonyms	Syssyn
Name/password	Sysusers	Sysalternates	USER.DDF	Sysuserlist	Sysusers
Authorization	Sysprotects	Syscolauth Systabauth Sysuserauth	RIGHTS.DDF	Syscolauth Systabauth Sysuserauth	Sysauth
Database	Sysdatabases	—	FILE.DDF	—	Sysdb
Key information	Syskeys	Syskeys	—	—	Syskeys

All of the database servers examined here have system catalogs—system tables that store information on database components such as tables, columns, and privileges. Most of the catalogs also have views, synonyms, and database and key information.

allowing other programs to read data but blocking updates, or exclusive update locks, preventing others from updating or reading data until the transaction commits (completes).

The SQL SELECT command puts a share lock on retrieved data. When the program updates the record, the server upgrades share locks to exclusive locks for each updated page. SQL COMMIT releases exclusive locks. This strategy provides a fine level of locking and maximizes transaction concurrency.

Because table locks allow only one user at a time to access an entire table, they restrict concurrency. While record locks seem the best option, they may diminish performance when compared with page locks. Page locks can lock many records at one time and go furthest to balancing concurrency and performance. The ultimate lock lets the administrator decide which tables are locked at which level.

Both NetWare SQL and ORACLE Server have crude locking managers that require extra work from programmers and administrators. SQLBase, XDB-Server, and SQL Server relieve programmers and users from locking records and maintaining data consistency. They provide high-level multiuser transaction concurrency and can manage high-performance, on-line transaction systems previously restricted to minis and mainframes.

NetWare SQL. NetWare SQL automatically locks tables unless programmers explicitly issue record locks, which makes locking a programming chore rather than an automatic mechanism.

A WAIT or NOWAIT lock command on each SQL program call overrides automatic table locks. NOWAIT returns control to the program when it tries to retrieve a locked record. It then has to reissue the SQL command or send a message to the operator. WAIT suspends the program until it can retrieve all records. In both of these cases, SQL COMMIT unlocks the table. As a programmer option, NetWare SQL's locking system is useful for light transaction applications.

ORACLE Server. ORACLE Server also automatically locks tables. By locking a table until a transaction is complete, ORACLE Server allows only one transaction at a time to complete execution, degrading performance.

The ORACLE SHARE mode puts a share lock on a table, which allows programs to read data concurrently from a table and prevents other users from updating its rows. Programs that issue EXCLUSIVE mode locks have exclusive control of a table.

Developers can get 2KB block-level locking under ORACLE Server's SHARE UPDATE mode by issuing a SELECT command with a FOR UPDATE clause. ORACLE Server places block-level locks on all pages retrieved by SQL SELECT. Once records are updated, ORACLE Server issues an exclusive lock on the table, which is not released until the transaction ends.

A special read-consistency mode permits users to read any record, locked or not. The record appears as it did. Read consistency provides a high level of concurrency as long as the program only reads and does not update records. It requires more overhead, however.

Deadlocks occur when two or more programs try to access or lock the same group of tables or records. Neither can proceed because each is waiting for a table or record the other has locked. ORACLE Server (like XDB-Server, SQL Server, and SQLBase) has automatic deadlock detection and randomly terminates one transaction.

SQLBase. SQLBase supports two isolation levels (the number of rows locked at one time): *repeatable read* locks all 1KB pages retrieved or updated with an SQL command and maintains those locks until they are committed; *cursor stability* locks only one record at a time depending on which page the program is reading. Cursor stability allows two or more programs to read the same set (one or more) of records but prevents two programs from simultaneously updating the same record.

Cursor stability is useful when a program reads several rows and works on only one at a time. It allows greater concurrency but less consistency than repeatable read; updating programs may change records that a reading program is accessing. Repeatable read yields higher consistency because the entire set of records is locked throughout the transaction. Read consistency permits users to read any record, locked or not. It has automatic deadlock detection and arbitrarily terminates one of the transactions.

XDB-Server. XDB-Server is the only one of these servers that supports automatic record locking. It also supports repeatable read and cursor stability and permits programmers to request table locks with LOCK TABLE as an adjunct to automatic block-level locking.

XDB-Server automatically escalates record-level locks to table-level locks if a program issues more block-level locks than allowed by the server's de-

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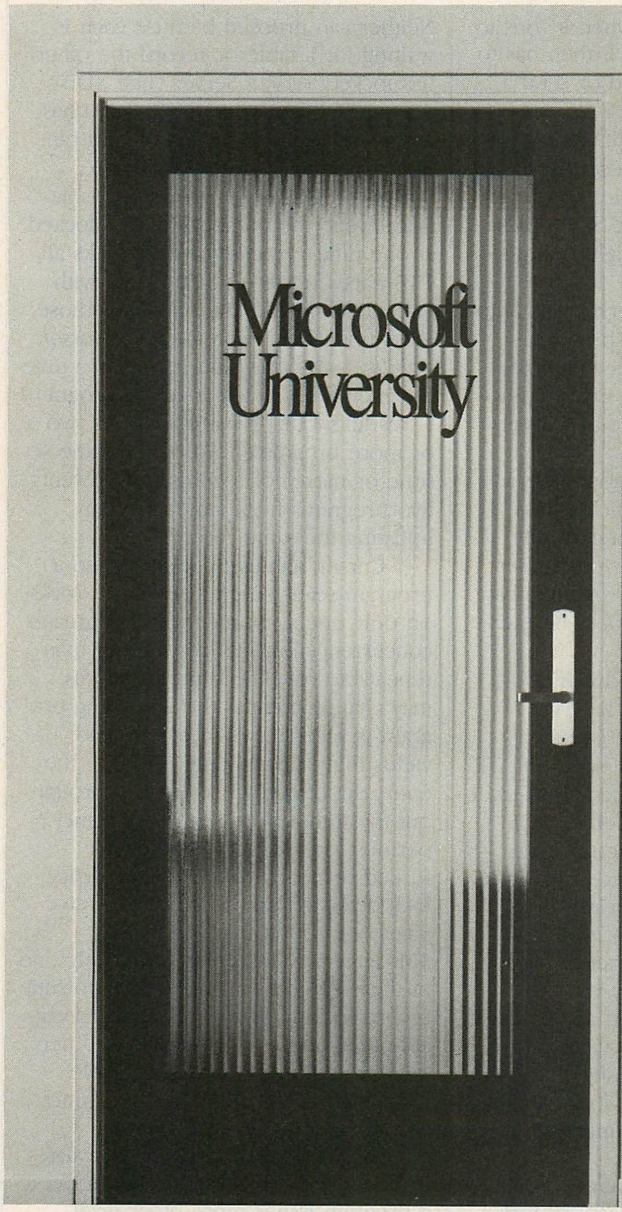

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TABLE 5: ***Locking Features***

	ASHTON-TATE/ MICROSOFT	GUPTA TECHNOLOGIES	NOVELL	ORACLE CORPORATION	XDB SYSTEMS
PRODUCT	SQL Server	SQLBase	NetWare SQL	ORACLE Server	XDB-Server
ISOLATION LEVELS					
Cursor stability	●	●	●	●	●
Repeatable read	●[a]	●	○	○	●
Read consistency	○	●	○	●	○
Dirty reads	○	○	○	○	●
AUTOMATIC LOCKING					
Table level	○	○	●	●[b]	○
Page level	●	●	○	○	○
Record level	○	○	○	○	●
DEVELOPER-CONTROLLED LOCKING					
Table level	○	○	○	●	●
Page level	○	○	○	○	○
Record level	○	○	●	○	○
OTHER LOCKS					
Intent locks	●	○	○	○	●
Deadlock detection	●	●	○	●	●
Livelock detection	●	○	○	○	○

● = Yes ○ = No

[a] *SQL Server uses HOLDLOCK command to simulate repeatable read.*
[b] *Table-level locks, unless SELECT FOR UPDATE is used. SELECT FOR UPDATE uses record-level locks for reads, but table-level locks for updates.*

Central to the role of the database server is lock coordination. Locks (share or exclusive) should be applied automatically by database servers so that individual applications cannot lock each other out of data tables. Of the servers reviewed, SQLBase, SQL Server, and XDB-Server all have advanced locking managers that include both repeatable reads and cursor stability.

fault or administrator-set number. This reduces locking-manager overhead but increases potential for deadlock if the locking manager tries to escalate to a table-level lock for one program while other programs are using the table.

Intent locks track locks on each table to help the manager decide if a lock will improve throughput. A *dirty read* bypasses locks for read-only queries. Concurrent access may be desirable if users understand potential data-inconsistency risks. XDB-Server has automatic deadlock detection and arbitrarily terminates one transaction.

SQL Server. SQL Server automatically escalates 2KB block-level locks to table-level locks if a program issues too many block-level locks. It also supports repeatable reads with the optional HOLDLOCK clause on SELECT.

SQL Server's automatic deadlock detection has a special algorithm that terminates the transaction that has done the least amount of work.

A *livelock* detection mechanism is used to detect overlapping read-only programs (share locks) stalling updates. Ashton-Tate/Microsoft's SQL Server automatically inactivates query transactions until the update executes. The intent locks of SQL Server is similar to the track locks on each table that is used by XDB-Server.

RECOVERING DATA COMPOSURE

All data managers should support automatic data recovery to offset program and system failures from hardware problems, power outages, or incorrect operator procedures. Programs may detect an error and terminate after they have partially updated a database, or an operator may detect an error and terminate the program.

Transaction recovery is based on logical-units-of-work (LUW). These are SQL statements that must be completed before any database changes can become permanent. The following example illustrates an LUW for an order-entry transaction:

```
BEGIN TRANSACTION
Read customer record from customer table
Insert order record in order table
Insert detail line-1 in detail line table
Insert detail line-2 in detail line table
Insert detail line-3 in detail line table
Update customer record in customer table
COMMIT TRANSACTION
```

If the transaction is interrupted before the COMMIT, the server restores the database to its condition before the transaction began.

Transactions begin when the program starts. (NetWare SQL and SQL Server have SQL-explicit BEGIN TRANSACTION statements, which can designate the beginning of a transaction anytime.) The end of a transaction may be designated by SQL COMMIT or implied by events, such as program termination. All updates and inserts of the order-entry transaction and related indexes must be successful before the LUW is considered complete. If the program or system terminates before all updates complete, the server automatically removes partial updates from the database.

SQL database servers track transaction updates on backward-recovery logs, which maintain images of all records before they were updated. If the program issues SQL ROLLBACK or crashes, the server's recovery manager automatically replaces partially updated records with "before" images.

For system failures caused by hard-disk errors or power outages, indexes and tables may contain partially updated records, partially updated indexes, and permanently damaged internal pointers. The administrator must recover the database to a backup, which loses all updates done after the backup and before the system failure.

To recover updates, all SQL database servers maintain a forward-recovery journal. If the log has updates of partially completed transactions, the data manager removes them from the

backward-recovery log. The forward-recovery log relieves the burden of reentering completed transactions and helps assure data are not lost.

NetWare SQL. NetWare SQL has no inherent transaction recovery management. It relies on Novell's Transaction Tracking System (TTS), which uses specialized I/O write techniques so any database server can control data integrity and transaction management.

ORACLE Server. For forward recovery, ORACLE Server uses AFTER IMAGE JOURNAL (AIJ), which is enabled by adding the **after_image** parameter to the ORACLE Server's initialization file. AIJ scans all after-image journals for committed transactions and displays them and all incomplete transactions on the operator panel to give a clear picture of how the database is being reconstructed. The server then reads committed transactions from the journal and updates the database backup.

SQLBase. SQLBase has a before-image file (rollback log) that keeps an image of the data to be changed until the user issues a COMMIT, and a forward-recovery log that stores all SQL statements that change data.

A BACKUP command backs up a database while database activity continues; RESTORE restores a backup done with BACKUP. APPLY JOURNAL reads the forward-recovery log and applies completed updates.

SQL Server. SQL Server has an advanced backup and recovery system providing both automatic and application-generated recovery. Automatic recovery, which occurs when the server restarts after a media failure, undoes all uncommitted transactions and rolls forward any transactions where the transaction log has been updated more recently than the database. The administrator specifies a maximum acceptable recovery time from which SQL Server determines an automatic checkpoint interval (for transactions to be written to the database). The CHECKPOINT statement can force a checkpoint.

A *dynamic dump* backs up databases or transaction logs without stopping data-entry operations. DUMP initiates a dump, and LOAD begins recovery. A Database Consistency Checker verifies that indexes are linked to table pages and properly sorted.

XDB-Server. XDB-Server uses a backward log to store before images and an optional forward log for recording database changes since the most recent backup. If either the application or server node fails, the server automatically rolls back incomplete transactions.

XDB-Server has BACKUP and RECOVER commands and a utility to check for database consistency, all similar to SQL Server.

SECURE IN THE KNOWLEDGE

Administrators use SQL's GRANT and REVOKE to enforce security, establishing which users can access which tables and views. Administrators can define views to fine-tune security, limiting user access. Views are defined using SQL commands with WHERE. To limit

SQL's GRANT and REVOKE commands enforce database security, establishing which end users can access which tables and views.

user access of a payroll table to one department, the administrator creates:

```
CREATE VIEW payroll_view
AS SELECT employee_name,
  employee_address
FROM payroll_table
WHERE dept_no = 'DEPT01';
```

Administrators give access to a specific user via a GRANT statement:

```
GRANT SELECT ON payroll_view
TO user_name
```

This means that **user_name** can look at **employee_name** and address for DEPT01, while payroll information is hidden. Privileges can be revoked with a REVOKE command. GRANT statements apply to tables, databases, plans, system privileges, and table spaces.

All these SQL database servers support the GRANT and REVOKE commands, although syntax differs. All versions should satisfy an organization's security requirements.

NetWare SQL. NetWare SQL's GRANT option is limited to table privileges. A unique CREATE GROUP statement grants security privileges to a group, saving the administrator from hours of misery spent granting the same privileges to many users. Encryption capabilities secretly encode data.

ORACLE Server. ORACLE Server grants these database-administration privileges: CONNECT permits users to login, RESOURCE allows users to create tables, and DBA allows users to execute database-administration commands. ORACLE Server also provides GRANT and REVOKE for table privileges; an administrator can give a user the right to use GRANT, decentralizing security.

SQLBase, SQL Server, and XDB-Server. SQLBase, SQL Server, and XDB-Server have GRANT statements for resource and table privileges. XDB-Server has GRANT commands on tables and databases, while SQL Server and SQLBase use GRANT commands on tables and resources.

THE TIP OF PERFORMANCE

Factors that affect database performance include the quality of the locking manager (does it use intent locks, how does it handle deadlocks), levels of locking strategies (table locks versus page locks), SQL optimization, operating-system overhead (single process/multithreaded versus multiprocess), and network overhead.

ORACLE Server's need to lock tables after each update can result in poor performance. It single-threads transactions—the worst possible scenario in a multiuser environment. However, ORACLE Server's and SQLBase's read-consistency capabilities promote superior concurrency among read-only transactions.

SQL Server's stored procedures reduce interaction between the application program and database server. These stored procedures and the products' livelock and deadlock handling boost performance.

XDB-Server has a well-designed physical architecture and good join algorithms in its optimizer, which should result in good performance. It is specifically designed for the PC environment, although it has been ported to Unix.

CONNECTING MANY PLATFORMS

For many organizations, connectivity and portability to other platforms is crucial to application development. VARs may need a database server that can run on DOS, OS/2, and Unix. Larger organizations may keep data on different computers but need to share data among applications. A company may implement an accounts-receivable system on a LAN using a database server. The system might store critical data but update a general ledger on a mini or mainframe. It would be advantageous to update both systems, in realtime, from one transaction.

SQL Server can support distributed database updates, but database integrity must be developer controlled. Developers must get involved with commit logic, which can be tricky. Support for distributed database queries is planned.

SQL Server is an OS/2 implementation of Sybase's SQL database server for minis. Sybase's server can run on many platforms including DEC VAX and Sun. When porting applications to any of these servers, the application interface remains the same no matter which platform the server is running on. SQL Server does not connect to DB2.

Gupta Technologies' SQLNet can connect one or more SQLBase servers over a network and have them all accessible to a given transaction. Applications can access local database servers or remote data managers, such as DB2. SQLNet uses IBM's advanced-program-to-program-communications (APPC) protocol. Developers reference a physical database, and SQLNet handles all connections. To the developer, the remote database looks like a local database server. Because SQLBase does not support distributed database updates, programmers can update only one database in a given transaction.

NetWare SQL, which runs as a value-added process (VAP) under the Advanced NetWare operating system, supports multiple servers on a Novell network, but remote servers send records one at a time, which degrades performance. Often-used data should be placed on a local server, and infrequently used data stored remotely. ORACLE's ability to run on various minis is useful for organizations that depend on diverse computer hardware. ORACLE Server supports limited distributed database queries so users on LANs can access remote Unix and VAX databases.

XDB-Server has been ported to various Unix and VAX platforms. It does not have remote APPC capabilities, but XDB Systems is working on distributed database support with full multisite update integrity. Currently, users can install multiple servers on one LAN, but can access only one server at a time.

THE PERFECT FIT?

Beyond the database servers currently available, few more entries are likely because of the complexity of development. The products described here, plus IBM's future OS/2 database server, VIA Information Systems' VIA/DRE, and a few non-SQL database servers (such as Zanthe's ZIM)—make up much of the market. The primary task for systems integrators is to determine which product best fits into their organization.

Ashton-Tate/Microsoft's SQL Server is a major player. It is robust, and capable of handling a variety of applications. It has the support of many third-party products—Ashton-Tate's dBASE IV, DataEase International's DataEase, Borland's Paradox—as well as Microsoft's languages and spreadsheet software.

Organizations with medium- and large-sized networks will find SQL Server gives them all the control and functionality they need to run mission-critical applications. Database administrators have a fine degree of control over their environment and can tune the system for decision support or high-transaction processing. Because SQL Server is a direct port of Sybase's data manager for minis, organizations can port to Sybase on Unix and VAX platforms. Microsoft, which owns OS/2 and LAN Manager, easily can tune SQL Server for that platform, too. All this comes at the cost of increased installation and administration overhead, so organizations with small networks may find SQL Server overwhelming.

Database servers soon will dominate the multiuser network marketplace, replacing file servers and even challenging mainframes.

When IBM's OS/2 Extended Edition is available as a database server, it will attract Fortune 500 and other large IBM customers. IBM is bundling its SQL Database Manager with its operating system and LAN system, making it an attractive, one-stop buying opportunity. IBM also will promote the homogeneous IBM database environment, which consists of DB2 or SQL/DS on mainframes and OS/2 Extended Edition Database Manager on PCs.

ORACLE Server also is vying for the high-end database server market, competing against SQL Server and IBM's OS/2 database server. The current version of ORACLE Server has the same installation and administration overhead as SQL Server, but neither the flexibility nor robustness. VAX and Unix ORACLE users, however, may find connectivity and portability of ORACLE Server on all platforms outweighs deficiencies.

XDB-Server, SQLBase, and NetWare SQL require less administration and fewer machine resources. They have DOS versions, and their vendors plan OS/2 versions. SQLBase and XDB-Server are highly compatible with DB2, and XDB-Server is portable to Unix. NetWare SQL is attractive to Novell's large and active Btrieve user base and users of other Novell products.

Database servers soon will dominate the multiuser network market, replacing file servers and challenging mainframes as the dominant platform for mission-critical applications. This will accelerate as more application-development tools take advantage of the qualities of database servers. These systems are just now making promises, but soon they will make inroads into business, combining the quality of mainframe data managers with the economy of PC systems.

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301/779-6030
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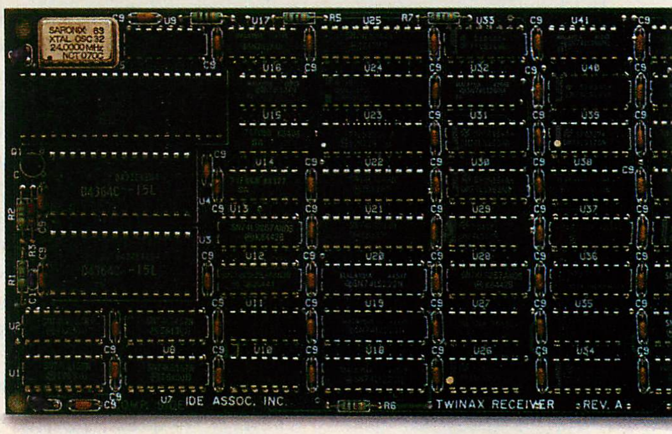
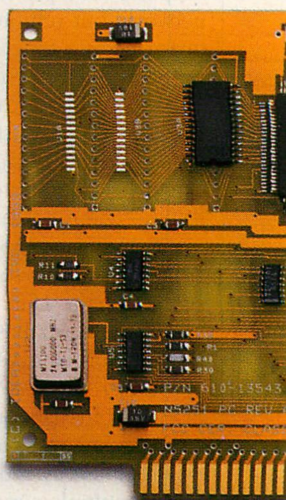
Richard Finkelstein is president of Performance Computing Inc., a Chicago-based consulting group specializing in relational technology. He is editor of Database Review *and is writing a book on SQL to be published by Howard W. Sams & Company.*



We've knocked 88 ch



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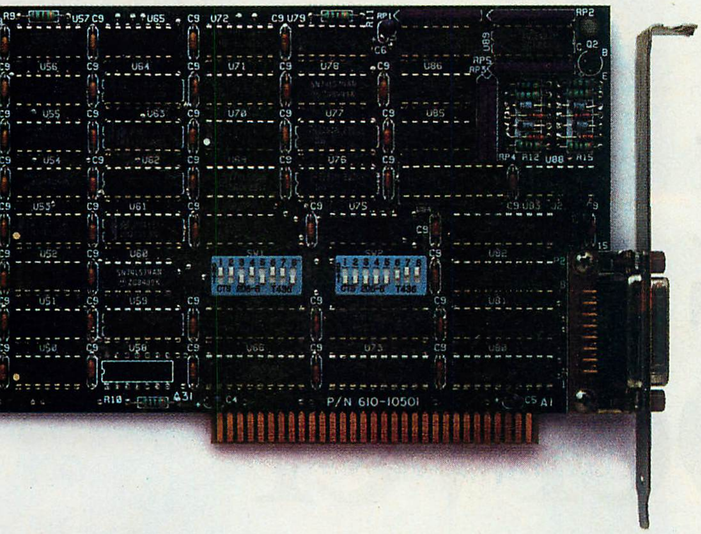

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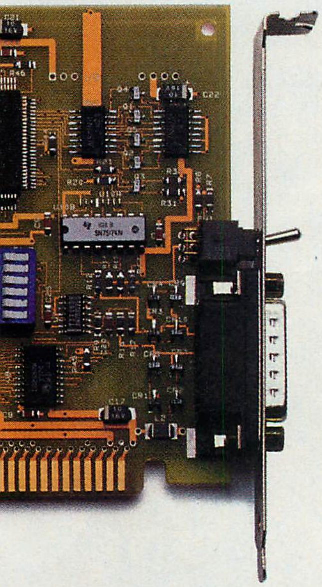

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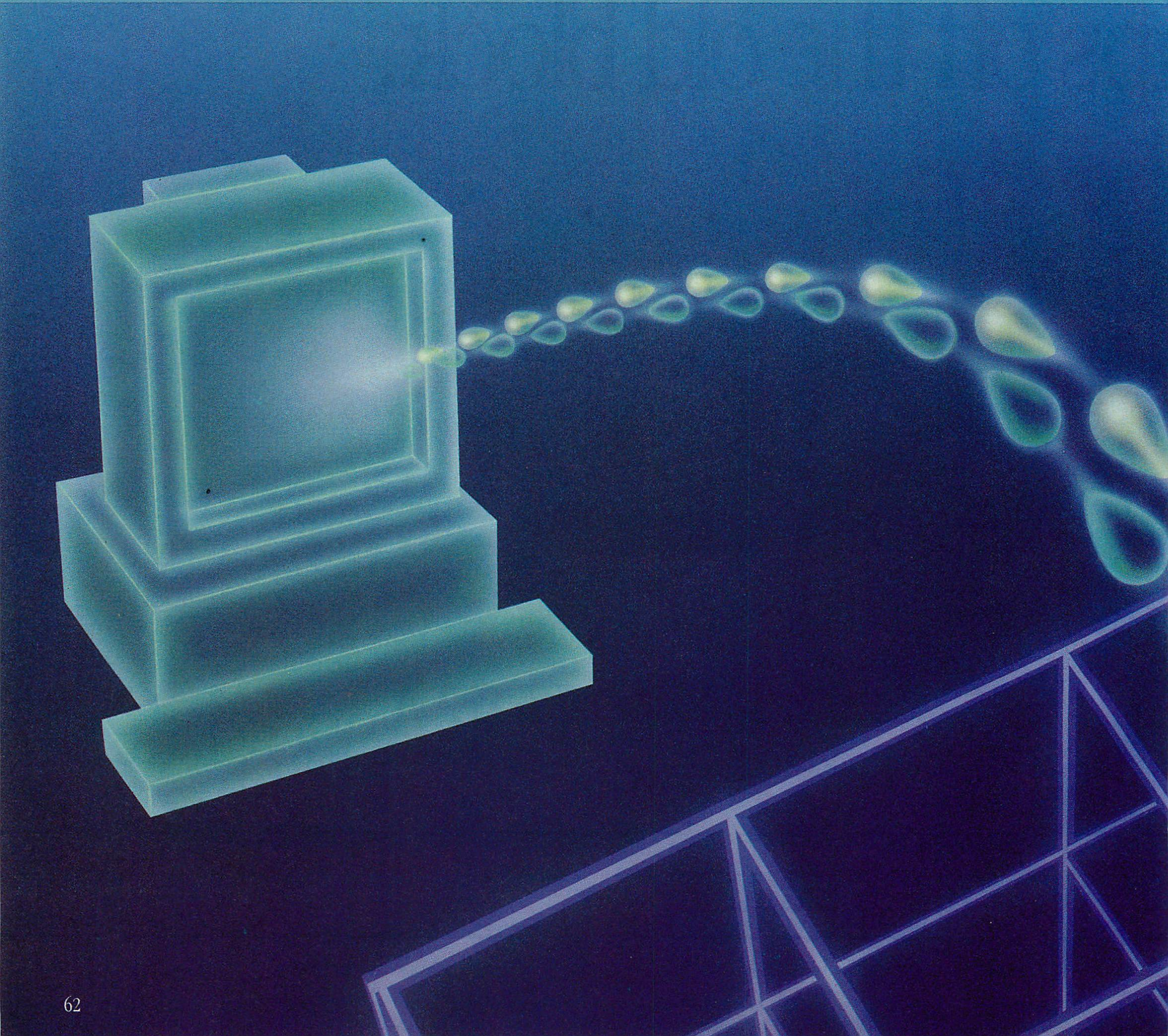


Front-end tools are key to tapping into the power of database servers. The first wave of such tools is reaching the market now. They will determine the style and type of distributed applications. How do they work, and how do you choose the right one?

HERBERT A. EDELSTEIN

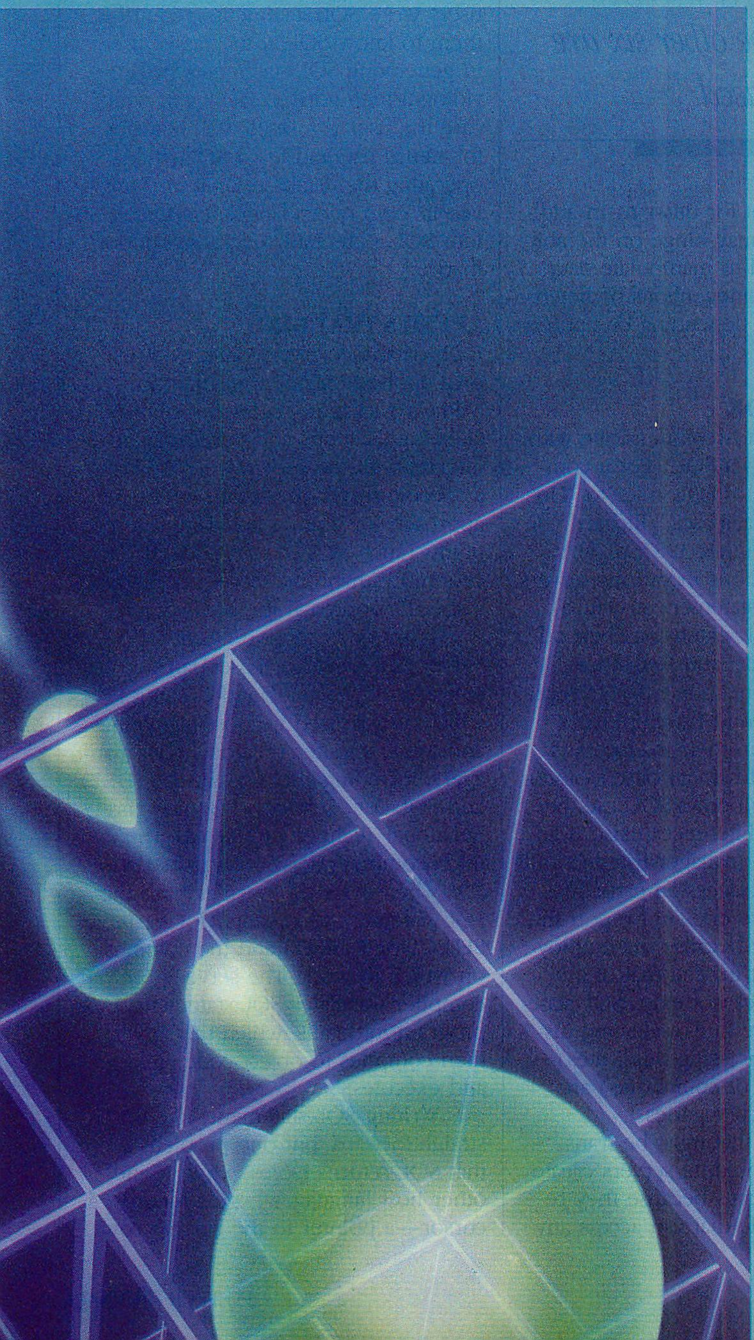


ILLUSTRATION • DOUG CHEZEM

Data manager vendors are rushing to the market with front-end tools that allow systems developers, integrators, and end users to access the mighty potential of database servers. Servers deliver central data security and integrity, reduce local area network (LAN) traffic, and optimize network performance on PCs. Developers and users interface with servers via front ends that provide tools for developing and accessing databases and that decentralize processing to ensure optimal user interaction, flexibility, and screen appearance.

Residing on a client machine rather than the server, a front end is used for building applications. It includes tools to generate screens, menus, and reports and provides query-by-example (QBE), query languages, or Structured Query Language (SQL) tools for easing data access. Once the front end builds an application, the server manipulates data in response to commands generated by the application.

The first wave of front ends for these database servers includes dBASE IV 1.1 from Ashton-Tate, Paradox 3.0 from Borland International, DataEase SQL from DataEase International, SQLWindows 1.1 from Gupta Technologies, XQL 2.01 from Novell, Professional ORACLE 5.1B from Oracle Corporation, and XDB-SQL from XDB Systems. Professional ORACLE, SQLWindows, XDB-SQL, and XQL are available; Paradox, dBASE IV, and DataEase SQL are not yet production versions. Even though the details of all of these seven products are not yet firm, *PC Tech Journal* examines them here to ensure that systems developers understand the concepts involved in order to do strategic planning.

The questions addressed are: What can front ends do? How do they work with servers? What issues are important for choosing a front end and developing under it? And which front ends best suit which target audiences?

Until now, data-management applications, the database kernel (engine), and the user interface and tools (front end) for manipulating databases had to share the same memory space. The server-client architecture separates these processes onto different machines and provides a method for communicating among them. The server performs the database engine activities of managing data; the front end resides on the user's PC (client machine) and supplies the interface and tools for building applications (such as menu and screen generators and report writers); the application also resides on the user's PC.

Front ends will determine how end users access databases, how developers write custom applications to run with database servers, and what choices integrators make in building such systems. They are differentiated primarily by (1) whether they are graphics based or character based, (2) which servers they work with, and (3) what application-development tools they offer.

SQLWindows from Gupta Technologies is designed for building applications that work in the graphics-based environment of Microsoft Windows and OS/2's Presentation Manager. The front end uses pull-down menus, dialog boxes, and a mouse. The other six front ends are character based. Although many of them have pop-up menus and build applications having windows, their windowing facilities are not as sophisticated as graphics-based windows and do not allow for sizing and other adjustments by end users.

SQLWindows, Professional ORACLE, XDB-SQL, and XQL are designed for use with their own servers—SQLBase from Gupta, ORACLE Server from Oracle, XDB-Server from XDB Systems, and NetWare SQL from Novell. dBASE IV is designed to work with Ashton-Tate/Microsoft's SQL Server (developed with Sybase). Because Paradox and DataEase SQL will work with more than one server, it is especially important to examine how they cope with server differences: they will work with SQL Server and IBM's OS/2 Extended Edition Database Manager. (Borland takes an interesting approach that will allow Database Manager to work as a server even before IBM releases it as such. The Paradox front end will contain a program that runs on the same computer with Database Manager and provides the code needed to make Database Manager function as a server.) Paradox also will support ORACLE Server and NetWare SQL.

When commercial applications specifically designed for database servers proliferate (such as Microsoft's Excel for SQL Server), many developers and users will venture into client-server technology for the first time. The preceding article ("A Database Server Odyssey," Richard Finkelstein, p. 42) examines five SQL database servers now available.

As for application-development facilities, DataEase SQL, dBASE IV, Paradox, and SQLWindows will allow developers to build comprehensive applications using their own languages, such as the dBASE language for dBASE IV applications and the Programming Application Language (PAL) for Paradox applications. XQL requires BASIC, C, FORTRAN, or Pascal for developing applications; Professional ORACLE and XDB-SQL provide menu-driven capabilities for developing applications, as well as host-language capabilities (C, COBOL, and FORTRAN in Professional ORACLE; C and COBOL in XDB-SQL).

Beyond objective evaluations of functionality, the personal preferences of users and developers are important tests. For example, those who like windowing environments may prefer SQLWindows, while experts in the dBASE language may opt for dBASE IV. In addition, the choice may hinge on the ability of a front end to manipulate data from multiple homogeneous or heterogeneous servers, depending on application requirements.

SQL Windows is graphics oriented, using pull-down menus, dialog boxes, and a mouse. The other six are character based.

THE SQL FACTOR

All these front ends communicate with database servers via SQL. (For a complete description of SQL, refer to "Lingua Franca for Databases," Richard Finkelstein, December 1987, p. 52.) SQL implementations in various servers differ in syntax (statement structure), functionality (their extensions beyond the ANSI standard), and semantics (statement interpretation). For example, the SQL statement to list employees earning more than their managers is the same for Professional ORACLE/ORACLE Server and SQLWindows/SQLBase, but subtle semantic differences exist. If an employee has no manager listed (a null value), ORACLE produces an error message, and SQLBase does not report the employee's name because the employee's salary cannot exceed that of a manager who does not exist. SQL statements that involve nulls, selecting distinct values (suppressing duplicates), and aggregation (or summaries) are susceptible to such vagaries.

Applications that must be transportable across multiple servers create developer headaches because they require writing code that can access any server's data reliably. Such applications include a personnel database within an organization that needs to run on different types of servers, any type of value-added reseller (VAR) application, and generic applications that consultants can sell to two or more clients. In these cases, developers may need to write two or more entirely different applications or one application with two or more sets of SQL queries to offset each difference, or the developer may use one of the transportable front-end languages, such as Paradox or DataEase SQL, in which the vendor has already addressed these differences.

In evaluating front ends, a primary SQL concern is how those running with different servers address the different dialects. Another issue is how the vendor integrates SQL into the front end. A front end may ask that users write SQL statements, requiring them to know SQL; it may assist users in generating SQL statements by providing a menu-driven facility, in which case the user can build SQL libraries for future use and learn SQL while operating the database; or it may translate its own query language statements into SQL, potentially degrading performance.

API TIES THAT BIND

Each database server comes with its own application program interface (API), a package of software routines to allow applications and developers to interact with the server. A front end to a specific server uses that server's API approach for writing host-language programs (such as C). Front ends that access more than one server may support a specific approach for each server.

Front ends supporting ORACLE Server and OS/2 Database Manager use *embedded SQL* (static and dynamic), which also is used in most mainframe and minicomputer relational data managers, including IBM's DATABASE 2 (DB2) and SQL/Data Services (SQL/DS) and Relational Technology's INGRES. The two microcomputer servers support *static SQL* when the user specifies both the SQL statement to execute (for example, SELECT or INSERT) and the columns on which to work. The server's precompiler translates SQL statements in a program into calls, which the server then compiles to object code, links, and executes.

Writing SQL statements like this is straightforward, but one problem is that SQL returns tables, while C and other host languages expect records. A cursor—a pointer to the current row

FIGURE 1: *Embedded SQL*

```
EXEC SQL DECLARE x CURSOR FOR      /* Declare a cursor x    */
     SELECT cnum, cname, city      /* to point to the rows  */
     FROM customer                 /* of the SELECT         */
     WHERE STATE = 'MD'            /* statement             */
EXEC SQL OPEN x                    /* Open the cursor and   */
                                   /* perform the select    */
EXEC SQL FETCH x
into :num, :name, :city            /* Fetch the first row   */
                                   /* into host variables   */
                                   /* num, name, and city   */
do while (sqlca.sqlcode == 0)
 {
   process data
   EXEC SQL FETCH x                /* Fetch next row        */
   into :num, :name, :city
 }
EXEC SQL CLOSE x                   /*Close the cursor       */
```

The APIs in ORACLE Server and OS/2 Database Manager use SQL statements embedded in a host language, such as C. The developer uses a pointer to read each row of the result table. A communications area (SQLCA) receives error messages.

FIGURE 2: *Call Interfaces*

```
/* Put the SQL in the command buffer */
dbcmd (dbproc, "SELECT cnum, cname, city from customer")
dbcmd (dprooc, "where city = 'Boston'");

/* Send the query to SQL Server */
dbsqlexec (dbproc);

/* Fetch and process the resulting data */
while ((result_code= dbresult(proc))) != NO_MORE_RESULTS
{
     if (result_code == SUCCEED)
     {
          /* Bind the database results to the program */
          dbbind (dbproc, 1, stringbind, 0, cnum);
          dbbind (dbproc, 2, stringbind, 0, cname);
          dbbind (dbproc, 3, stringbind, 0, city);

          /* Do something to the retrieved data */
          while (dbnextrow(dbproc) != NO_MORE_ROWS)
          {
               process data
          }
     }
}
```

Some servers provide a call interface to allow host-language programs to pass SQL as strings to the database server. SQL Server provides DB-LIBRARY; SQLBase, SQLBase API; XDB-Server, the XDB API; and NetWare SQL, the XQL Manager.

of data retrieved—solves the problem by allowing the developer to pick records from the table one at a time. The user issues a DECLARE CURSOR statement that specifies the SQL statement to be executed, an OPEN statement that causes the statement to execute, a FETCH statement to move a row of data into host-language variables, and a CLOSE statement to end the process (see figure 1 for an example).

For interactive programs in which constructing SQL statements depends on user input, ORACLE Server and Database Manager also support *dynamic SQL*. The developer places the text of the SQL statement to be executed in a host variable, which the server checks for syntax with PREPARE and executes with the EXECUTE statement. Communications between the server and the host variables occur in a server data area called the *SQL descriptor area* (SQLDA). Because no precompiling and prebinding are done, the server must parse, validate, and optimize access to SQL. This makes dynamic SQL slower and more complex than static SQL.

For writing host-language programs that run under SQL Server, SQLBase, XDB-Server, and NetWare SQL, front-end vendors use a *call interface* that passes SQL statements as a string to the database server. They provide DB-LIBRARY, SQLBase API, XDB API, and XQL Manager (XQLM), respectively. This approach is similar to dynamic SQL in that the SQL to be run is processed during program execution. The database access path (the steps the server takes to retrieve data) is optimized when the SQL is sent to the server. In figure 2, for example, the SQL Server code is equivalent to the embedded SQL in figure 1. SQL Server returns a table of data, and the front end uses a loop to access each row sequentially. Ashton-Tate and Microsoft are making SQL Server's DB-LIBRARY of functions available to third-party vendors for development of front ends.

XQL uses the *direct-file access* approach to writing host-language programs with its XQL Primitives (XQLP) facility. *Primitives* are subroutines that send low-level calls directly to the database, bypassing SQL and its associated database-server overhead. XQL requires that XQLP always access a view, which has a cursor ID. To obtain a view from the dictionary and assign it a cursor ID, the developer uses the XRECALL function. Because the dictionary is accessed, data security and integrity are not affected. Figure 3 shows how the function looks in C.

Directly bypassing the dictionary and read files is possible using Btrieve. This method, however, can result in loss of data independence because programs must know and use database file structures to access fields in a table; it also requires increased maintenance because, when a change occurs in one field, the data manager does not automatically change affected fields in different files unless the programmer writes a routine to do so. In addition, this method bypasses security and integrity checks, so it can be dangerous in multiuser situations. Although the direct-file access method can increase performance, a database server that optimizes queries should perform equally well without the same loss of data independence.

DOUBLE-DUTY PARADOX

The Paradox front end will be based on Paradox 3.0, the stand-alone data manager released in January (see "Paradox Made Better," New Directions, Will Fastie, February 1989, p. 21). This popular data manager is aimed at both end users and sophisticated application developers. Borland projects that an SQL translation facility will be added in the second quarter of 1989 to allow Paradox to act as a front end for ORACLE Server, SQL Server, and OS/2 Database Manager. To make earlier versions of Paradox function as a client, the company will provide a translator to convert QBE to SQL, a communications program for sending SQL statements across a network, and a server-interface component specific to each server supported. Borland will not release its own database server, according to company officials.

Users with Paradox loaded on their PC can use Paradox tools with both local Paradox databases and remote server databases; the company

intends that Paradox appear the same to users in both situations. Borland has an advantage integrating SQL into PAL because it is a set-oriented language, as is SQL. Data retrieved from the server go into a local Paradox table for manipulation by Paradox tools and merging with local data. Paradox uses both local and remote data, but the user cannot join local data to remote data until after the remote data come to the client, and data can be accessed at multiple servers, but only from one at a time. If Paradox were a true distributed database, it would support transparent data sharing among data managers anywhere in a network.

Paradox is a relational data manager with a character-oriented interface having menus, similar to Lotus 1-2-3 menus, at the top of the screen. With menus and function keys, developers can define databases, paint screens (forms), and write reports. PAL is a complete programming language in Paradox that helps developers create applications, and the Paradox Personal Programmer is a PAL generator that simplifies development.

The QBE facility, providing powerful, interactive data-manipulation capabilities, is easy to use for complex problems. Selecting Ask from the menu calls a query form, which is an empty skeleton of a table. Paradox lists table names from the server; you can specify those tables from which to retrieve data by placing check marks (using the F6 function key) under column headings. To retrieve rows that satisfy conditions, specify conditions under column headings. To retrieve data from multiple tables, place a dummy value in the columns that link the tables.

In release 3.0, Borland has added an *outer-join* capability to QBE, useful for retrieving data from one table when no matching values exist in a table to which it is to be joined. You need only put an exclamation mark in the linking column of the table from which the values are to be included. Although Paradox will take advantage of outer joins with ORACLE Server and SQL Server, it will return error messages with NetWare SQL and IBM's OS/2 Database Manager, which do not support these joins.

Borland also has added in release 3.0 *set operations*, which enable QBE users to place conditions on aggregates. For example, a single QBE in an order-entry database can determine which customers have ordered every part. This is similar to using SQL subselects.

FIGURE 3: *Direct Access*

```
int xRecall (iCursorID, sViewName, iOwnerCount,
sOwner, iOpenMode, iTextLen, sText)

where the returned values are:

iCursorID is the returned cursor id
sText is text you may have stored with the view
(such as a comment)
iTextLen is its length

The supplied values are

sViewName, the name of the view
sOwner, the owner names of the files in the view
if there is an owner
iOwnerCount, the number of owners in sOwner
iOpenMode, the read/write mode of the tables.
```

Only Novell's XQL Primitives (XQLP) use direct-file access to the database. The host-language program issues XQLP calls directly to a database view. XRECALL obtains a view from the dictionary and assigns a cursor ID.

For complex applications, developers can define single forms and reports that contain data from different tables. Tables can be linked hierarchically (only one level), so that if a master table row changes, detail rows also change. For example, if a customer name changes, all orders under that name will bear the new name. By allowing data from multiple tables to be included in a single report, Paradox no longer requires an intermediate table.

The new release supports *crosstab* reports, in which values from one field appear in the columns, values from another field appear in the rows, and a summary value is in the intersection of a row and a column. For example, in a crosstab report, each row might contain a sales representative and each column might list the products that person sold, with the total sales value at the intersection. The crosstab menu selection or the function key automates the creation of such reports. Developers also can combine crosstabs with other reporting functions, such as control break. For example, adding a break to a crosstab on sales of each part to each customer can provide data by each salesperson in each region.

Another new feature is a graphics facility that can create standard graphs, such as pie and bar charts. Support for PostScript printers provides for high-quality graphs and reports.

The DOS version of Paradox requires a 640KB machine with a hard drive; the OS/2 version requires 3MB of RAM. A separate DOS version for 386 computers takes advantage of extended memory.

Paradox 3.0 can translate queries into SQL for shipment over a network to a server (see figure 4). The communications module, which takes up only 8KB of memory under DOS, sends SQL statements to the server. Borland customized its Paradox agent, which resides on the server, for each of the supported servers. With SQL Server, the agent uses DB-LIBRARY; with OS/2 Database Manager and ORACLE Server, it uses dynamic SQL. Even though OS/2 is a single-user system, the agent approach takes advantage of multitasking to allow multiple clients to use OS/2 Database Manager as a server, and it reduces the memory requirements of the client. All knowledge of SQL differences resides in the Paradox agent.

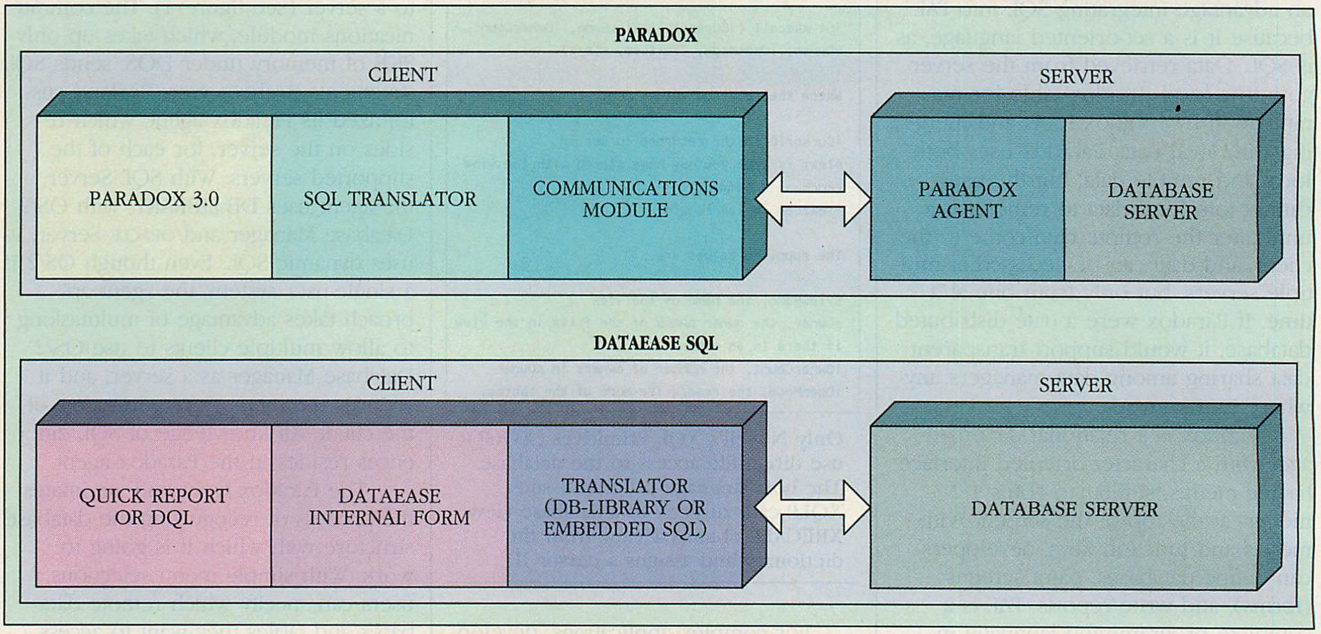
The Paradox front end automates the process of recognizing the database structure with which it is going to work. With simple menu selections, users can specify which remote databases and tables they want to access, give their user name and password, and press the DO-IT! function key (F2). The Paradox front end then moves the data definition from the server data dictionary to the local data dictionary. The system now knows where the tables are to be found, how to connect to the remote server, and which dialect of SQL to use.

The server is accessed in the same way as Paradox local databases. The user makes queries with QBE, which Paradox's SQL translation component deciphers into SQL. The communications module then passes to the server the SQL to be executed; the server returns the results to the client, where they are incorporated into a Paradox answer table.

In addition to embedding QBE (which is translated automatically into SQL), a PAL program can contain SQL statements. In response to a SELECT statement, Paradox automatically creates a table into which the front end places the retrieved data. Like any other Paradox table, it can be browsed forward and backward and joined to local tables. If an SQL function is not supported by the server, the front end returns an error message.

Later this year, Borland plans a new release of Paradox that will allow full QBE capabilities, including updating; all menu-based table operations, such as creating a table to be used with the server databases; and an interactive SQL window to the servers. Updating a server table involves using the Modify DataEntry selection from the main menu. This creates an empty table on

FIGURE 4: ***Paradox and DataEase Client/Server Link***



Paradox 3.0 provides an SQL translator to convert QBE to SQL statements and a communication module to send the SQL to the server. The communication module allows OS/2 Extended Edition Database Manager to function as a server. DataEase translates DQL to a DataEase internal form and then to SQL. Database Manager uses embedded SQL; SQL Server, DB-LIBRARY.

the screen having the same structure as the server table. Adding rows to the table merges data with the server table.

For general database updating, developers will be able to write PAL programs that send SQL statements directly to the server, which updates the database. The server's commands for COMMIT and ROLLBACK can be used for transaction processing.

In addition, the company plans to add the ability to mix queries on local and remote tables (but not on join tables) and data-definition commands, such as CREATE, DROP, and RENAME, on server tables.

DATAEASE POWERS UP

The current stand-alone release of DataEase SQL (4.0) by DataEase International adds significant application-development capabilities to its already good end-user facilities. For example, it extends its set-oriented procedural language called DQL (DataEase Query Language). The upcoming release of DataEase SQL as a front end, planned for sometime in 1989, will combine this functionality with database-server power. (For a review of DataEase 2.5, see "A Data Manager for End-user Development," Dave Browning, September 1986, p. 146.)

DataEase SQL initially will work only as a front end to SQL Server and not as a stand-alone database to access local databases. When IBM releases the multiuser version of OS/2 Database Manager, DataEase says it will ship a client version for it.

Application development with the DataEase SQL front end and its stand-alone version will be identical, except that the stand-alone version handles the transaction-integrity issues of locking and journaling (logging all changes to the database). With a DataEase/SQL Server combination, these functions are handled by the server. As long as the developer is aware of these differences, existing DataEase applications can run on supported servers.

DataEase SQL is character based and is navigated using menus and function keys. It is a *form-based* data manager, which means that developers define a database by painting data-entry forms on the screen, selecting field names and data types from menus. DataEase SQL automatically defines the corresponding data table. To define relationships between tables, developers can use a DataEase-provided form that prompts for table names and related fields, or they can specify relationships dynamically using DQL. A master form and subform enable you to define two levels of hierarchy; for example, an order form could be the master form and the subform could contain line items. The front end creates and passes data-definition commands, such as those for creating and defining tables, to SQL Server. Developers can use DataEase SQL's multiforms (forms containing fields from multiple tables) to format returned data for display.

The Quick Reports feature uses a form to specify selection criteria for data and generates either a default or user-formatted report.

For creating complex applications, DQL is a complete procedural language having assignment statements, loops, and case statements. Developers write control procedures to link forms created through the menu system with procedures to process them and create complex reports.

The hardware requirements for DataEase SQL are MS-DOS on a 640KB computer with a hard disk. DataEase also plans to release an OS/2 version but has not announced when.

Most DQL processing, including queries from Quick Reports and applications written in DQL, is table oriented. To access data on the server, DataEase SQL translates the DQL statements into DataEase Intermediate Query Language for subsequent translating into SQL (see figure 4). A DQL statement may contain clauses (such as conditionals) that have no SQL equivalents. In these cases, DataEase SQL parses the DQL and creates as many SQL statements as are needed to retrieve all the data required to execute the DQL query. The translator of the front end resides on the client and is server-specific. SQL Server, for exam-

ple, requires the DB-LIBRARY, while the IBM Database Manager requires a dynamic SQL program.

The translator knows the extensions and limitations of the server SQL and generates procedures to accommodate them. For example, financial and string functions in DataEase SQL have no counterpart in SQL, so DataEase SQL retrieves the data and processes the function on the client. All DataEase SQL capabilities can be used with the server, such as defining a database, querying it, and processing transactions. When defining a database, DataEase SQL takes advantage of SQL Server's rules and triggers to enforce data-integrity constraints (such as "no new orders for a specified part may be taken if the part has been back-ordered longer than two months"). The developer specifies these restraints in the database definition. If the database is already on the server, DataEase SQL automatically can determine the structure of the database.

DataEase SQL initially will not support interactive SQL, but will have an option to use the PC as a dumb terminal so that SQL can be run directly on the server database. A subsequent unannounced release is planned to support interactive SQL and work with a local database and remote server.

SQLWINDOWS, FIRST AT THE GATE

Gupta Technologies was the first company to ship a PC database server, SQLBase. With SQLWindows, Gupta also is first to ship a graphics-based front end. Graphics-based interfaces are excellent for developing easy-to-use applications, but building them under Microsoft Windows is difficult and time-consuming. SQLWindows simplifies the task.

Both SQLBase and SQLWindows are designed for use by systems developers. A command-oriented interactive SQL and report-writing tool called SQLTalk runs on the server; SQLWindows has a Microsoft Windows version of SQLTalk. Although these are not end-user tools, end users can be trained to use them. While SQLTalk alone is designed for interactive retrieval of data from SQLBase databases with simple report-writing capabilities, SQLWindows is a more comprehensive tool for building complete applications to run in a Microsoft Windows environment.

Express Windows is an extension to SQLWindows that automatically generates SQLWindows' code for user-painted screens. SQLWindows uses three types of windows: form windows (for data input and output), table windows (for rows and columns), and dialog boxes (for sending messages to users or accepting user input).

To develop applications, SQLWindows coordinates a Window Editor on the right of the screen and an Outline Editor on the left. The Window Editor, an interactive screen painter, allows developers to create complex forms with text, multiline tables, dialog boxes, scroll bars, pop-up menus, push buttons, radio buttons, and check boxes. As the user places these objects in the Window Editor window, SQLWindows automatically generates the code for producing them, which is displayed in the Outline Editor window. A change in one is reflected in the other. Because windows can scroll vertically and horizontally, a form can be larger than the screen.

The degree of distributed database support is higher in Professional ORACLE than it is in any of the other front ends.

Developers can use SQLWindows' menus to generate application pop-up menus that can include choices having keyboard equivalents. This is specified automatically in the SQLWindows Application Language (SAL), a procedural language providing standard features, such as local and global variables, assignment statements, branching, and conditionals. SAL also has many predefined functions (such as manipulating the database and windows, validating field contents, and debugging) that the developer invokes with a CALL. The developer can customize SAL functions and write external functions in C or assembly language.

A set of SQL functions in SAL can allow the application to access the underlying database, which is similar to the call interface in SQLBase. To retrieve data, call the SqlPrepare function, which validates a string containing SQL. SqlOpen executes the query; repeating SqlFetchNext retrieves specified rows. SqlFetchPrevious scrolls backwards, making data easier to browse.

Because SAL conforms to Microsoft Windows' programming interface, it is event driven (events, such as a menu click or field entry, send messages to applications). Developers can create window applications with or without accessing the database. SQLWindows can combine linked windows in a form. For example, one window can show students while another shows the transcript of the student pointed to by the cursor. Transcripts change as you scroll through the names.

Express Windows also aids in automating development under SQLWindows. It creates a default form for a database table for querying and updating, and it automatically creates SAL statements. The form reflects changes to SAL statements.

SQLTalk and SQLWindows require MS-DOS, 640KB, and a hard disk; they use extended and expanded memory when available to increase performance. SQLWindows also requires Microsoft Windows version 2.1 or later. The front end eventually will be available for use with OS/2 Presentation Manager (but no date has been set).

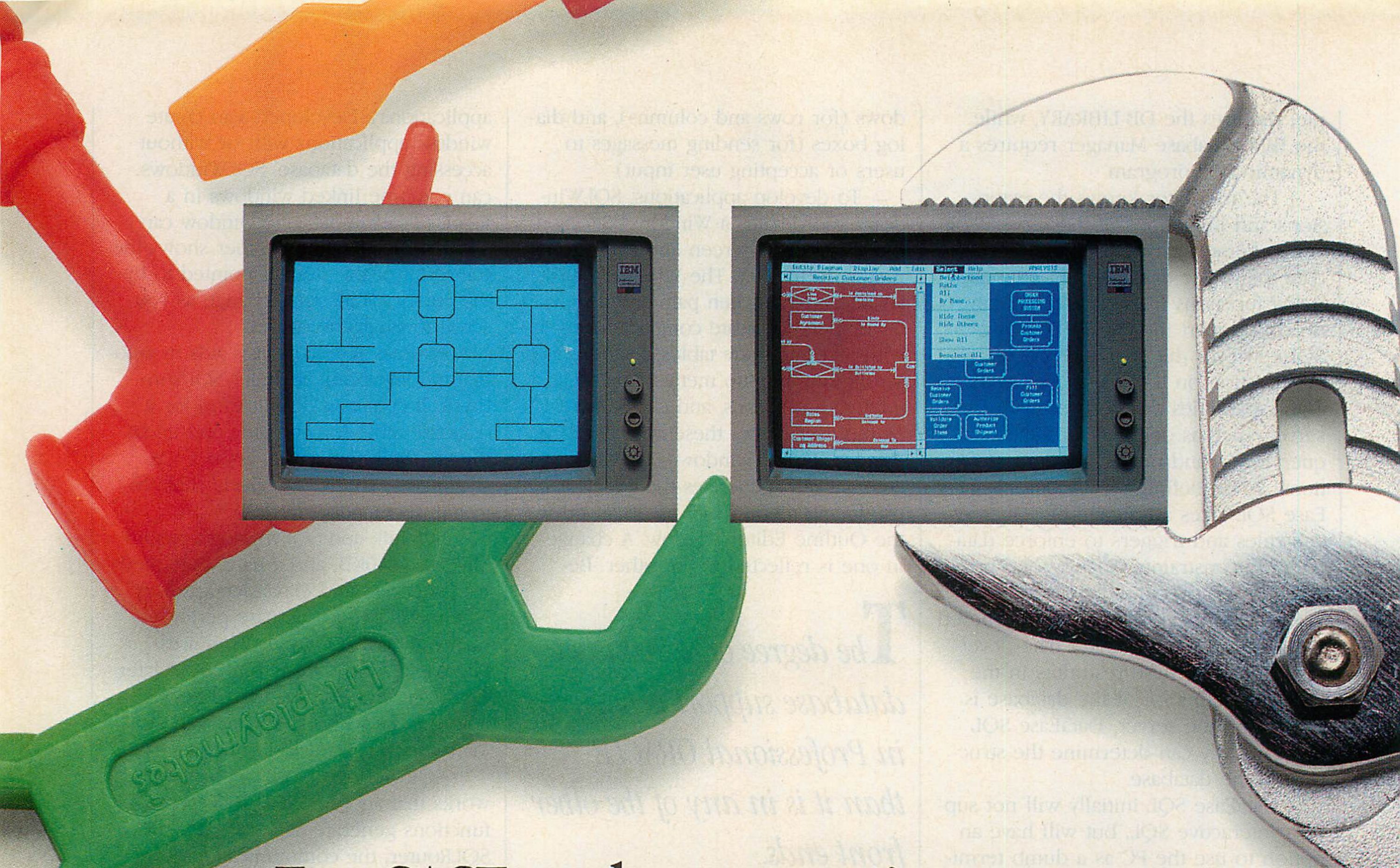
SQLWindows works with all networks that support NETBIOS. The SAL functions generate SQLBase API calls; SQLRouter, the communications component, sends them across the network to the server for processing before the data are returned to the client. Because SQLBase supports multiple open cursors, several SQL statements can be active at different points in the same database or on different databases in different servers. This is not a true distributed database because you cannot do distributed joins and updates.

Gupta plans to expand Express Windows to include new templates to handle hierarchical applications such as a master-detail on a form. SQLWindows works only with SQLBase. Gupta says it intends to support other servers, although the company has not announced which ones or when. Gupta issues runtime licenses at discounts.

DOMINANT dBASE

Earlier releases of dBASE have been the dominant PC-based data manager for many years. With the dBASE IV front end, Ashton-Tate has moved to shore up that dominance against increasing threats of new contenders.

Ashton-Tate's goal is to allow existing dBASE III and dBASE IV applications to run transparently with SQL Server. An application should not need alteration whether it is running with the dBASE IV engine locally or SQL Server remotely. In addition, non-dBASE applications should be able to run against a SQL Server database created to run with dBASE.



The central component of the new dBASE IV is the Control Center, the entry point for most application-development tasks, such as defining a database, querying it, writing reports, and defining forms. The user interface is character oriented, using menus and function keys for interaction. The dot prompt commands remain and may be used if desired. To facilitate writing complete programs in the dBASE language, Ashton-Tate is adding a new text editor and a debugging tool.

Developers and end users can query a database using a new QBE facility, similar to IBM's mainframe version. QBE generates dBASE IV programs for accessing the data.

The new interactive report writer provides an on-screen display of the report that is being designed. It produces columnar reports with multiple levels of control breaks. The new application generator uses labels, reports, and form definitions created in the Control Center to create menu-driven applications.

dBASE IV 1.1 has an SQL mode for using SQL to query a dBASE database directly, as well as a SQL Server database. Only the Developer's Edition, not the standard dBASE IV 1.0, comes with documentation for using embedded SQL.

dBASE IV requires 640KB and a hard disk running under MS-DOS. Future plans include support for OS/2. dBASE IV supports LAN Manager and LAN Server, and in the future will run on Novell's NetWare operating system.

The task facing Ashton-Tate in making the dBASE language work with SQL Server is extremely difficult because of the different data structures inherent in a dBASE database and the way the dBASE language uses those structures. All dBASE files contain a user-accessible record number, a timestamp, and a column marking deleted rows. These columns are required by dBASE IV programs but not by SQL Server. For example, dBASE IV has a function for finding a record by its number, as well as a command for going to a record with that number. Also, dBASE IV does not physically remove deleted records until the PACK command is issued. Finally, dBASE IV uses the timestamp to record the last time a record was updated.

The challenge for Ashton-Tate is to enable programs that use these structures to work transparently with a SQL Server database. When developers create a table for a SQL Server database using the dBASE IV front end, dBASE automatically creates columns showing record number, timestamp, and deletions in addition to the user-specified columns using triggers and stored procedures—features unique to SQL Server in the PC database market. The user does not know that a column called INTERNAL_RECNO is part of the SQL Server table. The triggers and stored procedures are executed whenever an application performs an update to a table. Even if the database is being accessed by a C program that has no explicit knowledge of these columns, the triggers in the data dictionary update the record number. When a dBASE application uses the database, it finds the record number that it needs.

With the dBASE IV front end, Ashton-Tate has moved to shore up that dominance against increasing threats of new contenders.

When an application accesses the server, dBASE IV code is translated to SQL in the front end's dBASE mapping layer. SQL in turn is translated to DB-LIBRARY calls passed to the server, which returns the data to the client. This translation process is difficult, because no one-to-one mapping exists between dBASE and SQL. Instead, many dBASE statements are frequently equivalent to one SQL statement, as in the following dBASE code:

```
use ORDERS in 1
use CUSTOMER in 2
select CUSTOMER
index on cnum to CUSTOMER
select ORDERS
set relation to cnum into CUSTOMER
list CUSTOMER->cnum, cname, orddate
```

This is equivalent to the SQL statement:

```
select CUSTOMER.cnum, cname, orddate
from CUSTOMER, ORDERS
where
CUSTOMER.cnum = ORDERS.cnum
```

Arithmetic statements, each of which generates a sequential scan of a dBASE file, are simply aggregates in an SQL statement. To make the problem more complex, dBASE IV has alternative ways for accomplishing the same tasks. For example, multiple tables in dBASE IV can be linked through a nested FIND, the SET RELATION TO command, or even a JOIN. Ideally, these should all map to the same SQL.

Ashton-Tate also has to make dBASE IV locking mechanisms compatible with SQL Server locking. dBASE IV supports record and file locks, whereas SQL Server supports page and table locks. The developer can elect to maintain either dBASE IV record-level locks or SQL Server locks. For record-level locking, Ashton-Tate uses a SQL Server database table as a lock table. dBASE IV defines a trigger on the server that automatically checks the lock table to prevent conflicts. If the page-level locking of SQL Server is being used, the timestamp checks whether the record has been changed since the user first accessed it. If it has not, the record will be updated; otherwise the update will be rejected.

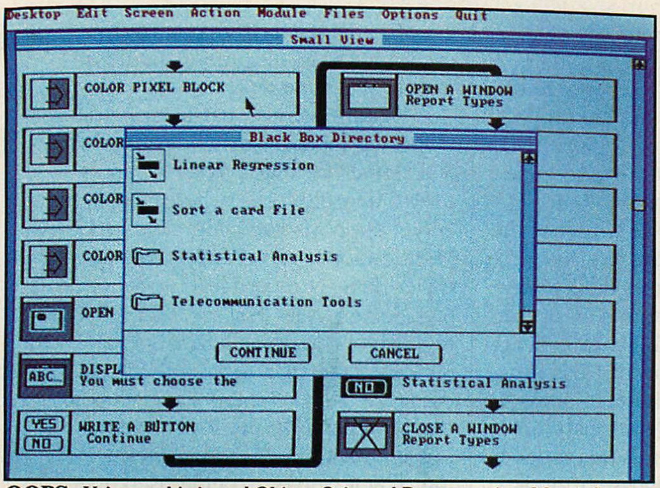
Records retrieved from SQL Server are buffered on the client so that in Browse mode you can move forward and backward through the retrieved set of records. If browsing goes past the end of the retrieved set, then the next set of records is retrieved into the buffer. Browsing backwards out of the buffered record set means you must issue a new SELECT, then reposition the pointer to the correct record.

The local dBASE IV database can work with the remote SQL Server database in a limited fashion. Data from the server can be retrieved into dBASE IV memory variables. The system then can switch to local mode and use these values with the local dBASE IV database. The reverse can be done to relate data residing in the local database to the server database. In addition, the local data can be copied to the server. Ashton-Tate has not announced whether the front end will support simultaneous access of both local and server databases.

The SQL component is an integral part of the Ashton-Tate database architectures. Ashton-Tate plans to use Interbase Software's InterBase database engine to provide local workstation support of SQL and heterogeneous interconnect (connection to different databases on different machines) to SQL Server and other data managers on mainframes, minis, and micros, such as IBM's DB2 on the mainframe.

ORACLE BODES WELL

Although the bulk of Oracle's business is in the minicomputer and mainframe worlds, it has released versions of ORACLE for the PC and Macintosh environments and recently released server ver-



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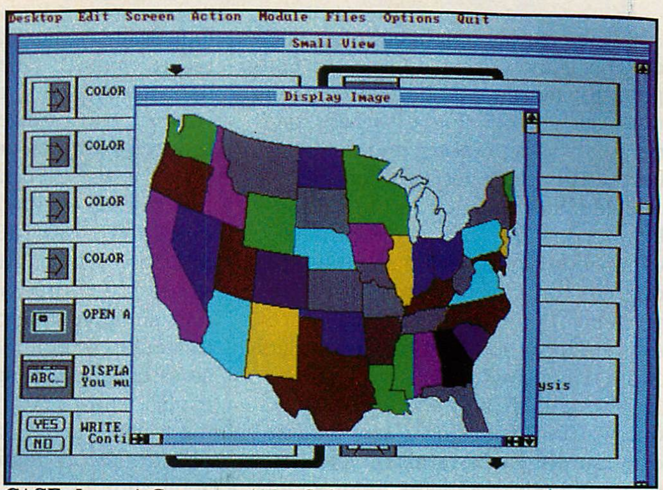

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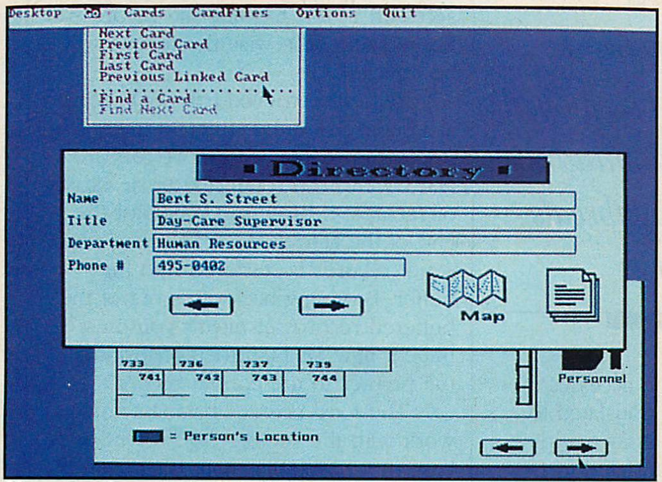

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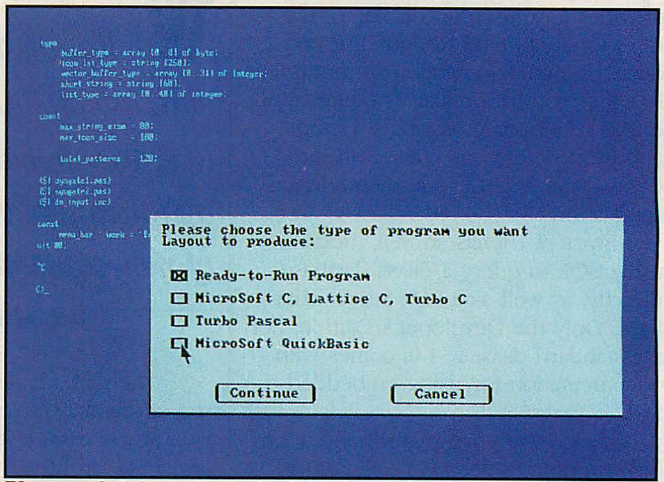

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sions that run under Xenix and OS/2. This array of products bodes well for connectivity across multiple platforms.

Professional ORACLE provides host-language interfaces to C, COBOL, and FORTRAN, using embedded SQL to accommodate complex, high-performance applications. (Refer to "Managing Databases, Mainframe-Style," Dave Browning and Hugo Blasdel, December 1987, p. 106, for a complete review of Professional ORACLE 5.1.)

Professional ORACLE front ends on a client machine can access a local ORACLE kernel or ORACLE Server on a server. The application tools that come with the front end are SQL*Forms (a forms-based application development package); SQL*Plus, an interactive SQL; SQL*Menu, a menu builder; and SQL*ReportWriter, a tool for writing reports. The complete single-user system is called Professional ORACLE, release 5.1B, and includes the application tools and the database loader.

SQL*Forms builds complex menu-driven, forms-based applications for data entry, retrieval, and modification. It uses ORACLE triggers, such as verifying that a value is in a user-defined range, for associating procedures with a form. These triggers are sets of commands and SQL statements that run when events occur, such as entering or exiting a form or field. Triggers can call other triggers. SQL*Forms does not produce any source code that the developer can check, nor do any tools exist, such as trace-on and cross-referencing, for debugging an application built this way.

SQL*Plus is an interactive SQL with extensions beyond the ANSI SQL standard, including outer join and nested aggregate support. Numerous functions and commands exist for specifying formatted reports. SQL*Menu creates a menu-based interface to the operating environment, ORACLE tools, and applications.

The new SQL*ReportWriter produces a wide variety of reports, including multilevel control-break, master-detail, multiple-section, and crosstab reports. A menu and fill-in-the-forms approach is used for defining reports.

QMX and Easy*SQL are end-user utilities also new to the PC product. QMX has QBE, interactive SQL, and the ability to construct multilevel, control-breaking reports. Easy*SQL provides a prompted interface for constructing some SQL statements such as SELECTs. It does not provide all SQL capabilities, but developers can enter SQL statements directly.

Except for SQL*ReportWriter, all these front-end tools can run together on a 640KB computer. SQL*ReportWriter requires 900KB of extended memory. All tools use extended memory if available.

To work with ORACLE Server, the user must have Oracle's SQL*Net PC. This communications program supports IBM's OS/2 LAN Manager and named pipes, NETBIOS, SPX-IPX, and asynchronous communications. By setting an array size parameter, the user can control the amount of data the server returns to the client.

As part of Oracle's SQL*Star architecture, front ends can access multiple ORACLE servers in the network and local databases on clients. The administrator identifies the remote servers on the network and qualifies the names of remote tables with their addresses during system configuration.

These are only the first wave of general-purpose and application-specific front ends likely to appear for PC database servers.

The degree of distributed database support is higher than any other front end described, but Professional ORACLE Forms is not a complete distributed system. This would require the server to perform joins before returning the result to the client.

Besides Professional ORACLE, Oracle Corporation will have other front-end versions available for use with ORACLE Server. ORACLE Quicksilver and ORACLE dBXL are targeted toward users of WordTech Systems' Quicksilver and dBXL products, respectively. ORACLE for 1-2-3 is for Lotus 1-2-3 users.

XDB'S ENTRY

XDB-SQL has a complete set of front-end tools to work with its server, including a QBE-type data-entry facility for tables and views, report writer, and fourth-generation language (4GL).

The front end is for use with the XDB-Server. The server's engine is small, quick, and complete. It even supports referential integrity in the data dictionary, so that developers do not have to code referential integrity checks into applications.

Accessing the XDB database is accomplished via SQL, which can be used interactively, from C and COBOL with a call-level interface, or through a query-by-form (QBF) facility in which users select data via menus or set conditions to find records. (For a review of XDB, see "The XDB Dynamo," Randall Rustin, April 1988, p. 140.) The server version is functionally identical to the stand-alone version.

The front end is character oriented with menu- and function-key-based interaction. Menu-based modules allow defining the database, entering data, and providing a menu-based interface to screens and reports. XDB-Forms, the forms manager available as an option, can create complex forms for data entry and retrieval.

The XDB Procedural Language is sufficient for the developer to build some routine applications, but more complex applications require the developer to turn to a host language.

XDB-SQL runs on any computer running MS-DOS with 640KB, a hard disk, and a network using NETBIOS.

Access to the server is transparent to the end user. The front end's redirector program intercepts database calls to the engine and sends them to the server. Groups of records are returned to the client as a string. XDB-SQL can run either as a front end to XDB-Server or as a stand-alone data manager. It works in both single- and multiuser environments.

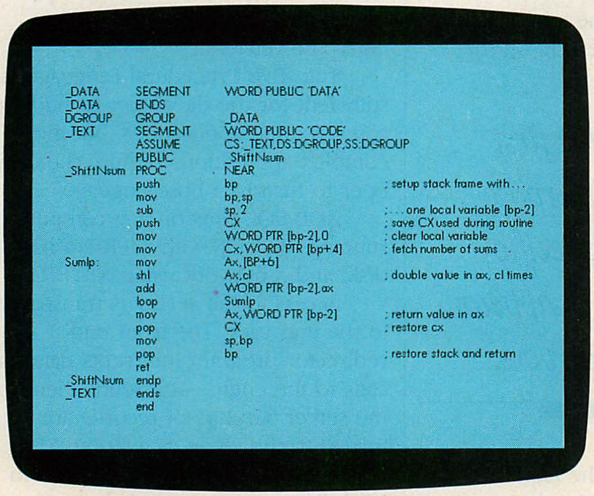
XDB plans to move to a graphics-based front end. The company also plans to link to other vendors' databases through its engine rather than the front end.

XQL AIMS AT SOPHISTICATION

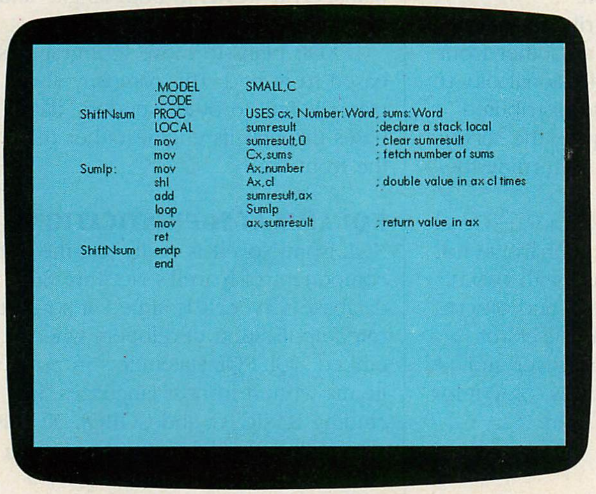
XQL from Novell is really just the SQL component of Novell's NetWare SQL database server. It is aimed at sophisticated application developers who embed XQL SQL statements in programs written in host languages, including BASIC, C, and COBOL. XQL is not a full-fledged front end; it has an interactive SQL component, but no tools for building screens and menus or writing reports. Third-party vendors, such as Borland, plan to offer products to work with XQL.

XQL runs on any computer supporting Novell NetWare and accesses the server through any of three levels: XQL Interactive (XQLI) is an interactive SQL facility for writing and editing SQL statements. The statements are sent to the server and data are returned as groups of records to the client.

Microsoft MASM 5.1 gives you two things you've never had in a macro assembler. OS/2 and spare time.



The old way: slow, cumbersome coding.



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- Sample macros for interfacing for DOS and OS/2 systems.
- Simplified segment directives make writing MASM subroutines easy.
- Comprehensive instruction set *reference* with examples.
- Programmer's Guide—complete guide to MASM features and instruction set.

Macro Assembler for OS/2 and MS-DOS
- Full OS/2 support to break the 640K barrier.
- Supports the 80386 and 80387 instruction set.
- Assembles 25-40% faster than MASM 4.0.
- Have labels local to a procedure.
- Declare stack based local variables within a procedure.
- OS/2 systems incremental linker—up to 20 times faster than a full link.

Microsoft CodeView Window-Oriented Debugger and Microsoft Editor
- Full OS/2 systems support.
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- Take advantage of the 80386.
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- OS/2 and MS-DOS reconfigurable programmer's editor.

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The XQL Manager (XQLM) is a facility developers use to construct subroutine calls containing SQL. For example, to retrieve data from the database, developers store the text of the SELECT statement in a program variable, establish a cursor for the statement using the function XCURSOR, parse and validate the statement using XCOMPILE, and fetch the rows, one at a time, using XFETCH.

XQL Primitives (XQLP), including XQL relational primitives, is a lower-level set of routines that bypass SQL to retrieve data by direct-file access.

The system administrator defines where the database is located on the network. The application sends XQL calls to the server, which processes the calls and returns the data. The developer does not need to know if the database is local or on the server machine. In addition to producing applications to access the NetWare SQL server, XQL can produce applications for a stand-alone data manager.

OUT IN FRONT

The front ends described here are only the first wave of general-purpose and application-specific front ends that are likely to appear for database servers. More will emerge as database-server vendors woo front-end vendors to increase the market credibility and visibility of their servers.

Systems developers and integrators are faced with many choices. In choosing a front end, developers and integrators must be sure it will run on the database server of their choice. The front end should also match the application-design style of users in an organization (for example, windows oriented, dBASE oriented, QBE, or perhaps a combination).

For large organizations and anyone anticipating applications that need to run with multiple servers, front ends designed for multiple servers, such as Paradox and DataEase SQL, may be the most attractive because of their portability and because they will run on Ashton-Tate/Microsoft's SQL Server. Those who prefer a QBE environment may prefer Paradox or dBASE IV.

The appeal of SQLWindows is that it helps develop applications that are visually more elegant than the other character-based front ends, and it works with the DOS version of the SQLBase server. For its part, the Professional ORACLE front end offers portability to the minicomputer and mainframe world with its widely used engine. Finally, XDB-SQL and XQL offer entree to their own servers. The choice to go with one of these front ends depends mainly on the server and an organization's application requirements.

This front line of front-end tools is only the beginning of the capability soon to be at your disposal for hooking into the power of database servers. Two major players in the PC software market—Lotus and Microsoft—have yet to release any front-end products or even disclose much public information about them. However, the technological skill and marketing muscle of these two giants cannot be ignored in the front-end arena.

Lotus plans to market a tool set with a graphics interface designed to work under OS/2 Presentation Manager. It will work closely with 1-2-3/G, which also will function as a data-management front end. The tool set will ship later this year. According to Lotus, it will include modules for defining, querying, and reporting on a database, as well as facilities for forms-based transaction processing and interactive SQL.

Until Lotus and Microsoft go public with their products, the market for front ends is likely to remain in a state of flux.

Lotus believes, as do most other vendors, that SQL is not an end-user language, and therefore the tools should not require a knowledge of SQL. Complex applications will be able to be built using the elements of the tool set in conjunction with the Lotus Extended Application Facility (LEAF), Lotus's promised API.

The Lotus server, developed from SQLBase by Gupta Technologies, will run under OS/2. Communications with the server will be based on the Lotus Blueprint communications architecture. Because this is also the architecture for 1-2-3/G communications, vendors who want to work with one will work with the other automatically.

Microsoft has been even more secretive about its front-end tool, Omega. If Microsoft has done as good a job on the product as it has on security, Omega will be dynamite.

dBASE IV, Paradox, DataEase SQL, SQLWindows, XQL, Professional ORACLE, and XDB-SQL may be first out of the starting gate—but until Lotus and Microsoft go public with their products, the market for front-end tools will likely stay in a state of flux. Their entry is bound to have an impact on this very young arena. Stay tuned.

Ashton-Tate
20101 Hamilton Avenue
Torrance, CA 90502-1319
800/437-4329; 213/329-8000
dBASE IV 1.1: $795; upgrade from dBASE II, III, or III PLUS, $175; dBASE IV, Developer's Edition, $1,295
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Borland International Inc.
800 Green Hills Road
Scotts Valley, CA 95066-0001
408/438-8400
Paradox 3.0: $725
CIRCLE 353 ON READER SERVICE CARD

DataEase International Inc.
12 Cambridge Drive
Trumbull, CT 06611
800/243-5123; 203/374-8000
DataEase SQL: Price not yet determined.
CIRCLE 354 ON READER SERVICE CARD

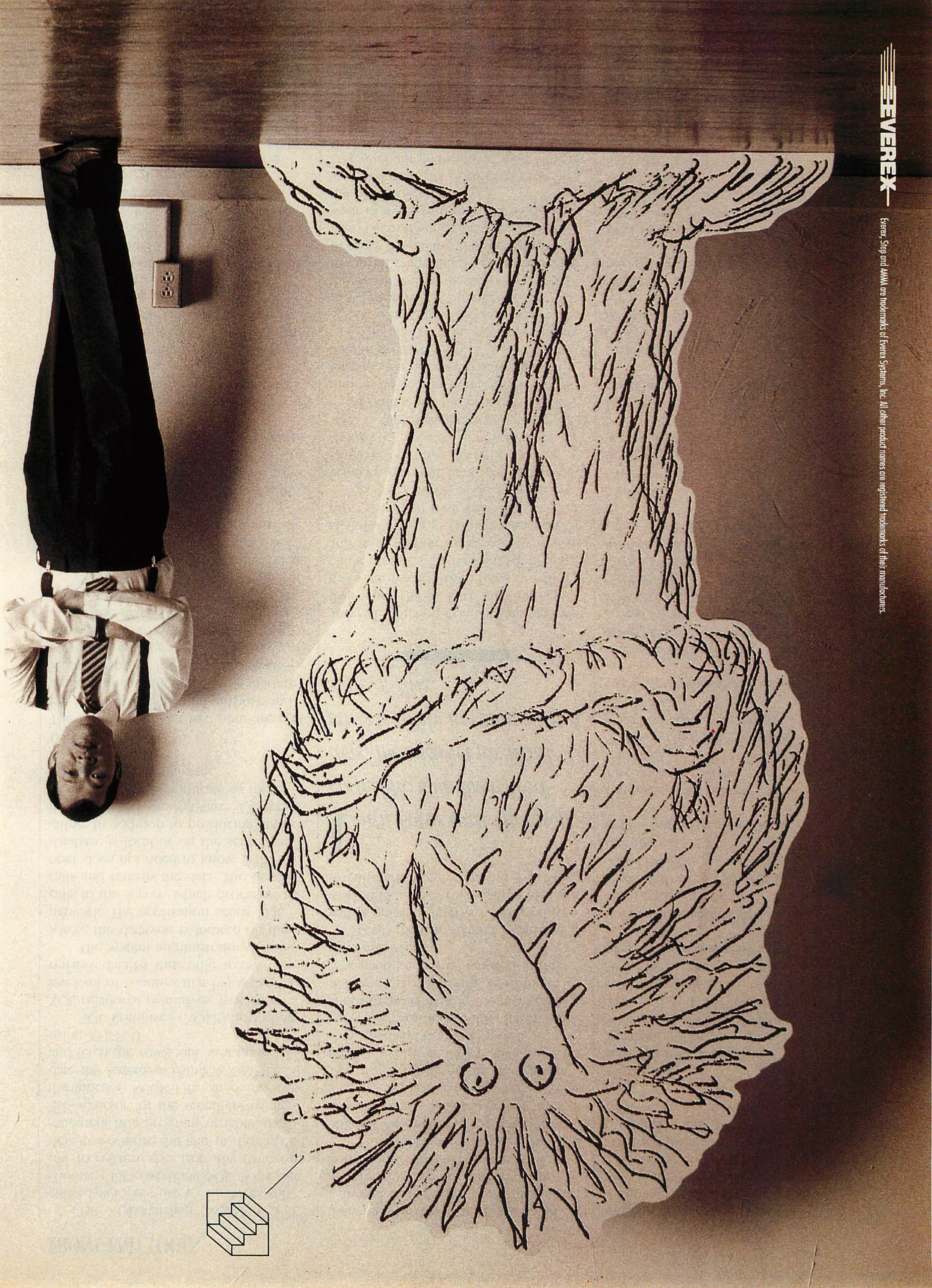
Gupta Technologies Inc.
1040 Marsh Road, Suite 240
Menlo Park, CA 94025
800/876-3267; 415/321-9500
SQLWindows 1.1, included in SQLBase starter kit: single user, $1,295; multiuser, $2,995
CIRCLE 355 ON READER SERVICE CARD

Novell Inc.
Development Product Division
6034 W. Courtyard Drive
Austin, TX 78730
512/346-8380
XQL 2.01: $795
CIRCLE 356 ON READER SERVICE CARD

Oracle Corporation
20 Davis Drive
Belmont, CA 94002
800/672-2531; 415/598-8000
Professional ORACLE 5.1B: $1,295
CIRCLE 357 ON READER SERVICE CARD

XDB Systems Inc.
7309 Baltimore Avenue, Suite 219
College Park, MD 20740
301/779-6030
XDB-SQL: $595
CIRCLE 358 ON READER SERVICE CARD

Herbert A. Edelstein is a principal of Euclid Associates, a consulting firm specializing in data management and desktop publishing.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Some Assembly Still Required

Despite advances in high-level languages, assembly language remains a necessary development tool for the fastest, most compact code and for programs that exploit the underlying hardware.

BEN MYERS

The primitive practice of programming in assembly language began in the earliest days of computing, when prehistoric programmers took the first step away from composing programs directly in binary and octal machine codes. The first assembler was to computing what the wheel was to transportation—the most basic form of work simplification.

Wave after wave of higher-level languages have steadily eroded assembler use. Increased computer speeds and, until recently, lower-cost memory, have fueled the trend.

Despite the onslaught, however, the assembler still has its place, although in a more limited role. In programs where speed and size are at a premium, high-level languages cannot compete with the capabilities of assembly language. It is common practice to determine which high-level language functions or procedures are hot spots in a program and rewrite them in assembly language for speed (sacrificing portability in the process).

Other programs remain within the domain of assembly language because their runtime requirements are not easily met by high-level languages. For PCs, these include device drivers, terminate-and-stay-resident programs (TSRs), interrupt service routines, and code developed for ROM. For developers of such applications, a good assembler has no alternative.

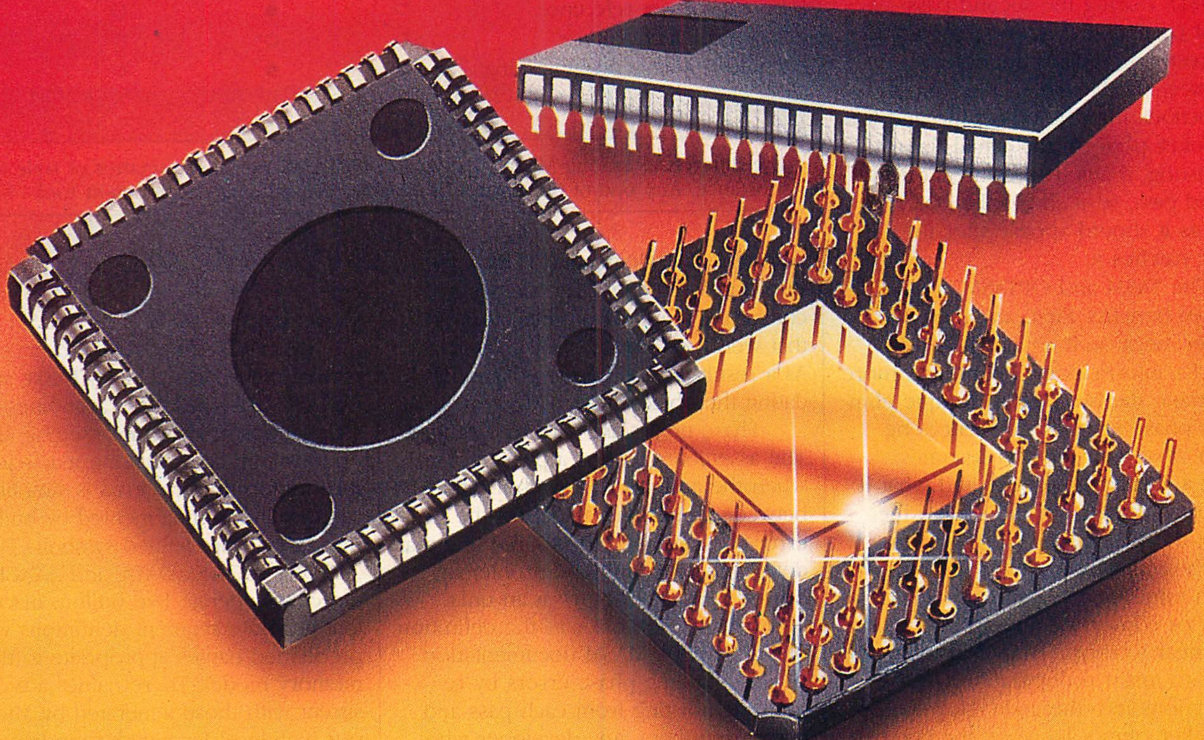
The major criterion in selecting products for this review was compatibility with Microsoft Macro Assembler (MASM) 5.0, a watershed in assembler implementation. The three assemblers chosen are MASM 5.1, Borland International's Turbo Assembler (TASM) version 1.0, and SLR Systems' OPTASM 1.5. Table 1 compares their features. IBM's Assembler/2, which is based on MASM 4.0, is a generation behind and, therefore, not included.

Microsoft's MASM, first released in 1981, was the first assembler for DOS. In fact, most of DOS was written using MASM. The product forms the baseline for comparison, then and now.

For many years, no other assemblers measured up to MASM (see "CHASM, PASM, and TASM," Ted Mirecki, December 1985, p. 161). Now, however, both TASM and OPTASM are viable alternatives, offering many attractive features that surpass those of MASM, including shorter assembly time, reduced programming effort, and more helpful information in listings. (The TASM that was reviewed in the referenced article is a different product manufactured by Speedware Inc.)

Part of the difficulty in creating an alternative to the Microsoft assembler is that MASM is a moving target—with each version come features that depart from previous iterations. A company that produces a competing product has three options: maintain compatibility with a previous MASM version and risk the label of obsolescence, strike out on its own and risk gross incompatibilities, or attempt to slavishly follow Microsoft's lead and necessarily lag behind MASM. In their own ways, Borland and SLR Systems strike a balance among

ILLUSTRATION • MICHAEL HILL



these alternatives. Their assemblers maintain adequate compatibility with past and present versions of MASM.

One significant feature not matched by the other two products is MASM's ability to execute under OS/2 protected mode. All three assemblers produce code that executes under OS/2, provided it is linked by a protected-mode linker. OPTASM also departs significantly in that it lacks support for 80386-specific instructions.

Although all three products accomplish the same goal, the internal architecture of the Borland and SLR Systems assemblers is different from Microsoft's MASM. TASM and OPTASM do not write any object code until they have made two separate passes through the source code. The first builds a symbol table with provisional addresses for memory locations, and the second adjusts the provisional addresses to reflect information obtained from farther down in the source code. Before it begins generating code, the assembler has complete information on the locations and other attributes of all symbols.

In contrast, MASM starts generating object code (and writing it to the output file) on the first pass through the source program. For forward references, MASM uses zero for the address and makes a best guess as to the size and distance of the operand. In many cases, the programmer can help MASM make more accurate assumptions by describing operands with key words such as NEAR, SHORT, BYTE, or DWORD. During the second pass, MASM corrects the addresses. Instead of directly modifying the object code, however, MASM writes linker fix-up instructions into the object file and lets the linker perform the actual fix-ups. The listing, if any, is produced on the second pass, so it shows the object code as it should appear after the linker patches it.

The TASM and OPTASM approach has two benefits. First, an object file is smaller, because it contains no address-fix information. Second and more important, the two-pass technique eliminates phase errors—differences between what an assembler assumes about a forward reference and what it subsequently finds in the source file.

If the final code can be shorter than the initial assumption (by removing an unnecessary segment override prefix or converting a jump instruction from near to short), MASM instructs the linker to insert no operation (NOP) instructions into the code. However, the linker cannot lengthen the code to accommodate elements (for example, inserting a segment override prefix or converting a jump from near to far) that were not inserted in the first pass. As a result, a phase error is fatal, invalidating the object file.

Phase errors are hard to diagnose. The assembler reports a phase error when the address of a symbol differs between passes and associates the error message with the source line that defines that symbol. The problem, however, usually occurs at an unlabeled instruction prior to the definition of that symbol. MASM documentation suggests finding phase errors by requesting a listing from each pass and comparing them. Any developer who has spent hours tracking down this type of error will appreciate the improvements of TASM and OPTASM.

Despite architectural and environmental differences, MASM, TASM, and OPTASM are similar in capabilities and share most of the same assembly time options (see table 2). One major feature uniformly supported is simplified segmentation, implemented by built-in macros and predefined symbols. The .MODEL, .CODE, .DATA, and .STACK directives operate like built-in macros that generate segment definitions with predefined names appropriate to the memory model. These names are consistent with those generated by Microsoft high-level language compilers, sim-

TABLE 1: ***Major Assembler Features***

	BORLAND	MICROSOFT	SLR SYSTEMS
PRODUCT	TASM	MASM	OPTASM
VERSION	1.0	5.1	1.5
PRICE	$149.95	$150.00	$125.00
ENVIRONMENTAL FEATURES			
Assembles 80386 instruction set	●	●	○
Runs in OS/2 protected mode	○	●	○
On-line help	○	○	●
Configuration utility	○	○	●
Debuggers supported	Turbo	CodeView, SYMDEB	CodeView, SYMDEB, Turbo
SYNTACTIC FEATURES			
Simplified segment directives	●	●	●
Tiny model (.COM programs)	●	○	●
Language-specific stack handling	●	●	○
Automatic sizing of transfers	●	○	●
LENGTH operator rationalization	●	○	●
Local labels	●	●	●
Conditionals in STRUC	○	●	●
Duplicate field names in STRUCs	○	○	●
ELSEIF constructs	●	●	○
UTILITIES INCLUDED			
Text editor	○	●	○
Debugger	●	●	○
Linker	●	●	○
Library manager	●	●	○
Make	●	●	Integral
Touch	●	○	○
Pattern search (GREP)	●	●	○
Source cross-reference	●	●	Integral
Object cross-reference	●	○	○
View/modify .EXE files	○	●	○
DOCUMENTATION			
Assembler syntax/directives	●	●	●
Instruction set reference	○	●	○
Processor architecture	○	○	○
Mixed-language programming	●	●	○

● = *Yes* ○ = *No*

The differences among MASM, TASM, and OPTASM are more a matter of style than substance. Any one of the three is a capable, professional development tool.

TABLE 2: *Command-line Options*

OPTION	MEANING	BORLAND TASM	MICROSOFT MASM	SLR OPTASM
/A	Alphabetize segments	●	●	●
/C	Generate cross-reference	●	●	●
/D	Generate pass 1 listing	○	●	○
/D*symbol*	Define symbol	●	●	●
/E	Emulated 8087 support	●	●	●
/G	Make all symbols global	●	○	○
/H	Display command-line options	●	●	●
/I*path*	Directory for include files	●	●	●
/J*direct*	Insert assembler directive	○	○	●
/KH*num*	Hash table capacity in bytes	○	○	●
/KS*num*	String space capacity in bytes	○	○	●
/L	Generate normal listing	●	●	●
/LA	Generate expanded listing	○	●	●
/M	MASM emulation	●	○	○
/M*x*	Preserve case sensitivity	●	●	●
/N	Suppress symbol table in listing	●	●	●
/P	Check for pure code	○	●	●
/R	Real 8087 support	●	●	●
/S	Order segments sequentially	●	●	●
/T	Suppress nonerror messages	●	●	●
/V	Verbose assembly statistics	●	●	○
/W	Suppress warning messages	●	○	○
/W*x*	Set warning level	○	●	●
/W-*xxx*	Disable specific warning	○	○	●
/X	List false conditionals	●	●	●
/Z	Display source line for each error	●	●	●
/Zd	Put source line numbers into .OBJ	●	●	●
/Zi	Full debugging information into .OBJ	●	●	●
/ZT	Turbo-specific debugging information	●	○	○

● = *Yes* ○ = *No*

Just as source files are, for the most part, compatible among MASM, TASM, and OPTASM, so the commonality of many assembly time options means that most make files can be used with any of the three assemblers reviewed here.

plifying the incorporation of assembly-language routines in programs written in other Microsoft languages. Another advantage to simplified directives is that each new segment directive (or end of source file) automatically terminates the previous segment, eliminating block-nesting errors.

Figure 1 compares a "Hello World" program written with and without simplified segment directives. Although simplified directives are easier to write and understand, occasions still arise when the developer must write full directives. An OS/2 device driver, for example, requires that the data segment precede the code segment. With simplified directives, the assembler always places the code segment first.

Although simplified directives hide the actual segment names in the same way a compiler does, the developer still needs to know the names. A segment or class name, whether generated automatically or coded by the programmer, cannot be used as a label. The following code, for example, produces two error messages:

```
        .MODEL  SMALL
        .DATA
CODE    DB      0FH
_TEXT   DB      'ABC'
        .CODE
```

The .CODE directive creates a segment with the name _TEXT and class 'CODE', thus conflicting with the two labels in the data segment. If the developer does not know the names generated by the directives, the reason for such errors will remain a mystery.

Unfortunately, Microsoft's documentation of automatically generated class names does not match MASM's actual behavior, and versions 5.0 and 5.1 generate different names (see Tech Notebook, July 1988, p. 137). MASM 5.1 generates class names of 'DATA' for the .DATA and .CONST directives, 'BSS' for .DATA?, and 'STACK' for .STACK.

This highlights an interesting dilemma for developers of competing assemblers. Should they emulate MASM's documented or actual behavior? If the latter, which version? TASM and OPTASM go separate ways. TASM produces the same results as MASM 5.1. OPTASM heeds what Microsoft says, not what it does. The difference, however, is unlikely to cause problems in most production programs.

DISTINCTIVE FEATURES

A major consideration for any developer in the market for a new assembler is how the product will be used. Factors such as utilities, for example, become secondary for those who write primarily in a high-level language and less often in assembly language. Most high-level language compilers already include a linker, a librarian, and a debugger. Other features to evaluate include the depth of the product's macro facility and the range of program directives. Microsoft, Borland, and SLR, offer nearly complete assembly environments. Each product, however, has features that set it apart from the others.

Microsoft. MASM is the most self-contained and completely documented assembler, providing all the features necessary for building and testing systems of arbitrary complexity. At $150, the MASM package includes an editor, linker, make utility, the CodeView debugger, and a variety of minor utilities in addition to the assembler itself. All these programs are either family-mode .EXE files that run in both DOS or OS/2, or are supplied in two versions, one for each operating system.

The assembler itself (MASM.EXE) comes in two versions; the first is a family-mode executable for both DOS and OS/2 and the other is for DOS only. The latter is 14KB smaller but not measurably faster, so on a system that runs both DOS and OS/2, only the first version need be installed. An automated installation procedure is provided, or the files can be copied manually. A PACKING.LST file describes the contents of each of the five diskettes.

FIGURE 1: ***Full and Simplified Segment Directives***

USING FULL SEGMENT DIRECTIVES

```
DGROUP    GROUP   _DATA, STACK
_TEXT     SEGMENT WORD PUBLIC 'CODE'
_TEXT     ENDS
_DATA     SEGMENT WORD PUBLIC 'DATA'
_DATA     ENDS
STACK     SEGMENT PARA STACK 'STACK'
          ASSUME SS:DGROUP
          DB      100h DUP (?)
STACK     ENDS
_DATA     SEGMENT WORD PUBLIC 'DATA'
          ASSUME  DS:DGROUP
MSG$      DB      'Hello World!', 0Dh, 0Ah, '$'
_DATA     ENDS
_TEXT     SEGMENT WORD PUBLIC 'CODE'
          ASSUME  CS:_TEXT
HELLO     PROC
          MOV     AX,_DATA        ;DATA ADDRESSABILITY
          MOV     DS,AX
          CLI                     ;HOLD OFF INTERRUPTS
          MOV     SS,AX           ;SET STACK REGS
          MOV     SP,OFFSET DGROUP:STACK
          STI
          MOV     DX,OFFSET DGROUP:MSG$
          MOV     AH,9            ;DOS DISPLAY FUNCTION
          INT     21h
          MOV     AX,4C00h        ;TERMINATE
          INT     21h
HELLO     ENDP
_TEXT     ENDS
          END     HELLO
```

USING SIMPLIFIED SEGMENT DIRECTIVES

```
          DOSSEG
          .MODEL SMALL
          .STACK 100h
          .DATA
MSG$      DB      'Hello World!', 0Dh, 0Ah, '$'
          .CODE
HELLO     PROC
          MOV     AX,@DATA        ;DATA ADDRESSABILITY
          MOV     DS,AX
          CLI                     ;HOLD OFF INTERRUPTS
          MOV     SS,AX           ;SET STACK REGS
          MOV     SP,OFFSET STACK
          STI
          MOV     DX,OFFSET MSG$
          MOV     AH,9            ;DOS DISPLAY FUNCTION
          INT     21h
          MOV     AX,4C00h        ;TERMINATE
          INT     21h
HELLO     ENDP
          END     HELLO
```

Simplified segmentation, introduced in MASM version 5.0, forms the dividing line between current and obsolete assembler implementations for the Intel architecture. The savings in the length of source code, and hence the effort on the part of the developer, are evident in this comparison.

Microsoft's MASM 5.1 significantly expands the high-level features first introduced in MASM 5.0, adding both automatic register saving and stack management to the automatic segment naming of the previous version. The .MODEL directive in version 5.1 can specify the language whose conventions will govern the order of arguments on the stack and the method of managing stack frames. Developers can designate Microsoft BASIC, C, FORTRAN, or Pascal. For example, the statement .MODEL MEDIUM,C establishes the stack management consistent with the medium memory model of the Microsoft C compiler. Without the language operand, the .MODEL directive operates exactly in MASM 5.0; using .MODEL enables several other high-level language enhancements.

One of these enhancements is the automatic declaration of all procedures as PUBLIC. Another is that operands on the PROC directive can describe the registers used within a function or procedure, as well as the arguments passed into it. With these options, the assembler automatically generates instructions to save and restore registers, to set up and relinquish a stack frame, and to set up definitions for referencing via the BP register all the arguments that are passed on the stack. For example, the following directive tells MASM that the registers SI and DI must be saved at entry into the procedure and that a word is passed onto the stack as an argument:

FOO PROC USES SI DI, DWORD arg1

MASM automatically equates **arg1** to a text string of the form [BP + *xxx*], where *xxx* is the offset of the argument on the stack appropriate for the memory model declared by .MODEL. Similarly, LOCAL allocates dynamic variables on the stack and sets up equates for referring to them via BP.

Another effect of the language operand of .MODEL is that all symbols defined in a procedure are local to that procedure; as in C, symbols defined outside procedures are known throughout the source file. Each procedure, for example, could contain the label EXIT without generating duplicate-symbol errors. More importantly, this prevents branching from one procedure to the middle of another, enforcing a more structured coding style.

Several other new features are in effect regardless of the use of language operands. Unnamed local labels can be established with the @@: symbol; jumping to @B transfers control to the most recent such label before the jump instruction, while @F transfers to the nearest one in the forward direction.

Several new macros and directives make it easier to write more general source code. @CPU provides information about the processor selected for assembly, using the .186, .286, .286P, .386, .386P .8087, .287, and .387 directives; this allows creation of several processor-specific programs from one source file. @Version defines a text string equal to the version of MASM (currently it is '510'). To facilitate writing conditional-assembly directives in a more structured fashion, every IF*xxx* directive (for example, IFNB) has a corresponding ELSEIF.

New string directives manipulate text strings at assembly time, typically within macros. SUBSTR returns a substring of a string of a given length beginning at a given character. CATSTR concatenates strings together. SIZESTR returns the string length. INSTR returns the index indicating the starting point of a substring.

The format of MASM's displayed error codes is now consistent with the scheme for Microsoft programming tools. Error messages are identified by code in the form *Xdnnn*, where *X* identifies the program (*A* for assembler, *L* for linker), *d* is a digit giving the error level (warning, serious, or fatal), and *nnn* is the error number. MASM 5.1 comes with CodeView 2.2, in separate versions for DOS and OS/2 (see "Multilevel Debugger," Mark S. Ackerman, March 1987, p. 90). Enhancements to the OS/2 version include the ability to trace multiple

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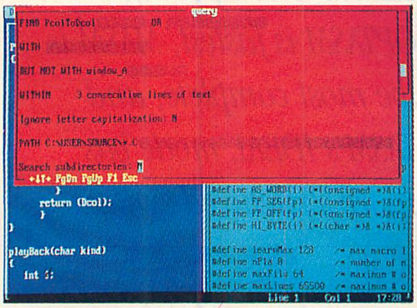

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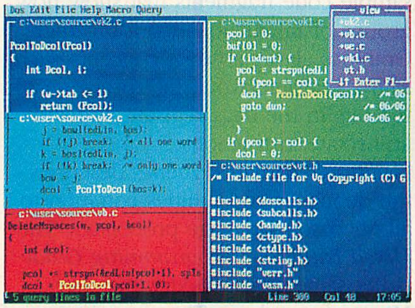

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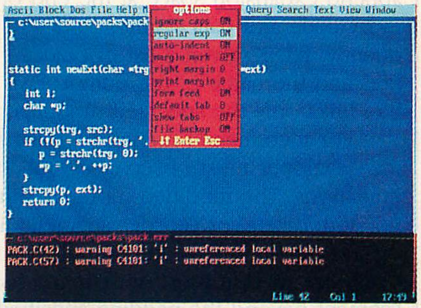

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threads of execution. Both versions support the display of data structures and pointer variables. For DOS, CVPACK compresses .EXE files to allow larger programs into memory along with CodeView.

LINK, MAKE, and LIB are supplied in family-mode versions for both DOS and OS/2; their use is essentially unchanged from previous versions. One enhancement is that MAKE can redirect the STDERR output of processes it calls, permitting collection of all messages in a file rather than having them scroll on the screen. This option (activated with the /X switch) is undocumented for DOS, but shows in the help message when MAKE is run with no commandline parameters. MEGREP is a generalized regular-expression search utility similar to Unix's **grep**.

ILINK, a new program, does incremental linking of DOS and OS/2 programs. It relinks only program parts that have changed since the last linking. The developer prepares a program for incremental linking by first performing a complete link with LINK.EXE using the /INC option. During this process, the /PADCODE and /PADDATA options append expansion space at the end of every code and data segment. Subsequently, ILINK, given a list of object files and the name of the output .EXE file, links only the specified modules.

For incremental linking to work, the developer must observe several limitations. The modified modules must not add, delete, or reorder segments in the executable file. If any module has been extended, it must not expand its segment beyond the padding specified during the last full link. ILINK cannot resolve changes to link libraries and calls to libraries not referenced in the last full link. However, ILINK is useful for maintaining a multiple-module program. It can save considerable time in rebuilding, especially in the final stages of development when only a few modules are changing.

The Microsoft Editor is similar to an EMACS editor, with provisions for keystroke macros, customization of keystrokes, and extension by programming in a subset of C. The editor also handles multiple source files.

Several other utilities for examining and modifying .EXE files round out the MASM package. The most useful, EXEHDR, displays the contents of an .EXE file header for DOS and OS/2 programs. Although the documentation implies that the utility is used only for OS/2 and Windows programs, it works for standard DOS programs as well.

MASM 5.1 documentation consists of the four identical manuals supplied with MASM 5.0: the *Programmer's Guide*, *CodeView and Utilities*, *Mixed Language Programming*, and *MASM Reference*, plus an *Update Guide* that describes only the features added in the new version. Except for the reference manual, these are all paperback volumes about 7 by 9 inches and are less durable than the loose-leaf manuals supplied with Microsoft compilers and MASM 4.0. The reference manual is a smaller, spiral-bound booklet.

The 466-page *Programmer's Guide* is not intended as a complete tutorial, but lists other tutorials and books on 8086-family programming. The first 12

> *Each is compelling: OPTASM is fastest, MASM is the most complete, and TASM's IDEAL mode has more structured syntax.*

chapters explain the command-line options, assembler directives, and cross-reference utility (still a separate program). The next 8 chapters describe each class of instruction and give many sample code fragments that show how groups of instructions work together. Graphics clarify abstract concepts such as the register layout, interpretation of the bits in the flags register, and shift and rotate instructions.

CodeView and Utilities describes the debugger and utilities common to all Microsoft language processors. The *Mixed Language Programming Guide* is the same as supplied with other Microsoft products. This organization of the MASM documentation separates the language-specific and the general information into separate volumes.

The 148-page *MASM Reference* contains nearly everything the PC programmer needs for writing assembly language programs and can practically replace an *Intel Programmer's Reference* for a particular microprocessor. The first section is a concise reference of the command-line options of the assembler and all utility programs; the second summarizes the assembler directives. The bulk of the reference is devoted to describing processor and coprocessor instructions, with notes explaining which ones execute on which processors. It provides instruction timings in number of clock cycles for each type of processor. The last section has some useful tables, including the layout of the DOS program segment prefix, an ASCII code chart, and a table of keyboard scan codes.

Unfortunately, the reference has not been updated for version 5.1, and it contains no information about enhanced language support or other new features. For that, the user must refer to the *Update Guide*, which has three main sections: on the assembler itself, on CodeView and the utilities, and on the Microsoft editor. Besides describing the new features of each program, the guide gives detailed information on using each under OS/2 and documents the OS/2 development tools BIND and IMPLIB (see "OS/2 Workshop," Ted Mirecki, August 1988, p. 80).

Borland. Turbo Assembler is available as part of three different packages offered by Borland. Bundled with Turbo Debugger, it lists for $150. Both assembler and debugger are part of Turbo Pascal Professional and Turbo C Professional, each of which lists for $250. TASM is highly compatible with MASM 5.1 and contains many MASM features already discussed.

The assembler package contains three diskettes, the *Turbo Assembler User's Guide*, *Reference Guide*, and the *Turbo Debugger User's Guide*. The manuals are all 7-by-9-inch paperbacks. A menu-driven program manages the installation of TASM and the accompanying utilities. The package includes a separate, dedicated installation program for Turbo Debugger's two diskettes. (See "Turbo Debugging," Ben Myers, January 1989, p. 46.)

Besides the debugger, utilities included with TASM are a linker, librarian, cross-referencing program for both source and object files, MAKE, TOUCH, and GREP. TASM offers all of the syntactic features of MASM 5.1. It has assembly options to mimic MASM 4.0, 5.0, and 5.1, dealing with the changes from version to version. It also has a QUIRKS option that copes with ambiguities in MASM and an IDEAL option that enforces strong data typing and a syntax more rigorous but quite different than MASM's.

The IDEAL mode is the one feature that sets TASM apart from MASM and OPTASM. Borland views this mode as a more rigorous syntax for writing programs. For example, under IDEAL mode, the value returned by the LENGTH operator corresponds to the actual byte count of a data item, not

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the size of each element (1 for the DB directive, 2 for DW, and so on). The period character is not acceptable in a directive within IDEAL mode syntax, so MASM directives that begin with a period have equivalent IDEAL mode directives. For example, MASM's .CODE becomes CODESEG in IDEAL mode, and .LALL becomes %MACS. Table 3 provides examples of syntax differences between MASM and TASM's IDEAL.

When a large production program (the one used in test 3, described below) written in MASM syntax was assembled in IDEAL mode using TASM, 100 fatal and 24 warning messages were generated. IDEAL users should think of it as a different assembly language dialect, incompatible with Microsoft's de facto standard assembler.

The TASM diskette holds a series of useful archived include files with definitions for the most-used BIOS calls, documented DOS calls, and keyboard scan codes. It also has macros for the most common BIOS and DOS function calls, as well as macros to manipulate Pascal strings and addresses in segment:offset format.

TASM adds a PWORD directive to define variables that are compatible with 6-byte Turbo Pascal real variables. It also has a UNION directive, identical in function to the C **union** construct. A union provides for the definition of data elements of different types that occupy the same memory locations.

TASM provides a way for conditional jumps to be expanded so they can exceed the 128-byte limit. The option is enabled with the JUMPS directive and is disabled by default. This is a wise default, because MASM does not have this feature, and TASM does not always generate the best code when JUMPS is on and the code references forward labels. For example, the assembly source code

```
  JZ    DONE
  INC   CX
  JMP   LOOPTOP
DONE:
```

generates the instructions

```
  JZ    DONE        ; 2 bytes
  NOP               ; 1 byte each
  NOP
  NOP
  INC   CX
  JMP   LOOPTOP
DONE:
```

TASM inserts the NOP instructions, because it does not know whether the label DONE is more than 128 bytes away, and reserves three bytes for a far jump in case it is. This could affect time-critical code, because three NOPs are now executed in the loop's body.

TABLE 3: ***Examples of Syntax Differences***

MASM	TASM IDEAL MODE
.286	P286N
.286P	P286
.MODEL	MODEL
.DATA	DATASEG
.DATA?	UDATASEG
.CONST	CONST
.STACK	STACK
.FARDATA	FARDATA
.FARDATA?	UFARDATA
.CODE	CODESEG
TITLE A Sample Program	%TITLE "A Sample Program"
INCLUDE MYMACRO.INC	INCLUDE "MYMACRO.INC"
aaa STRUC	STRUC aaa
xxx MACRO arg1,arg2	MACRO xxx arg1,arg2
yyy SEGMENT STACK	SEGMENT yyy STACK
zzz PROC near	PROC zzz near
zzz ENDP	ENDP zzz
cmp BYTE PTR [si],0	cmp [BYTE si],0
mov ax,SavedVal	mov ax,[SavedVal]
mov cx,Field[bx]	mov cx,[(aaa ptr bx).Field]
mov ax,es:[bx][si]	mov ax,[es:bx+si]

Differences between MASM and TASM in one-word directives are easily fixed with an editor's global replace command, but differences in the syntax of the instruction operands can effectively prevent the porting of a MASM program to TASM.

The TASM *User's Guide* opens with a beginner's introduction to assembly language programming. Subsequent chapters explain TASM command-line options and discuss assembly language programming in progressively greater detail. These chapters have examples and accompanying charts and graphics to clarify more complex concepts. The manual covers interfacing TASM modules with Turbo BASIC, Turbo C, Turbo Pascal, and Turbo Prolog, with explanations of calls in both directions. It includes advanced assembler topics, such as structures, records, macros, and segments. The last two chapters analyze 386 programming and attempt to justify the IDEAL mode.

Most of the 297-page *Reference Guide* is an alphabetized description of TASM features divided into three categories: predefined symbols, operators, and directives. Appendixes summarize TASM syntax in Backus-Naur notation, explain MASM compatibility issues, and summarize the TASM highlights.

Another appendix explains how to use the utilities that come with TASM. These include the cross-reference, make, and library manager programs familiar to any MASM user, along with a few others. The TOUCH utility changes the creation date and time of a file to current; this forces MAKE to rebuild a program. GREP is a regular-expression search utility similar to Unix's **grep**.

The program linker, TLINK, is largely compatible with Microsoft's LINK, but it cannot link overlays or object files produced by Microsoft C or FORTRAN compilers. In many cases, TLINK builds programs faster than LINK. It can produce either .EXE or .COM files, eliminating the need for EXE2BIN to create a .COM file.

Together, the *Reference Guide* and the *User's Guide* provide a fairly thorough treatment of the subjects of programming in assembly and using TASM. To round out a complete set of reference materials, though, you will have to add a reference book for all the instructions, such as one of the Intel programmer's references.

SLR Systems. Several features of SLR's OPTASM, which lists for $125, differentiate it from the others. First, it is the fastest by a significant margin. Some of its features also reduce the clerical effort in writing programs. Its configuration program allows assembly to be customized with 48 independent settings, and it has on-line help for much of the information needed by a pro-

grammer. Its cross-reference and make facilities are built-in, rather than being supplied by external programs.

OPTASM supports MASM 5.0 features, but not those of 5.1. It also differs significantly from both MASM and TASM in that it does not assemble 80386-specific instructions.

Materials delivered with OPTASM consist of a single, 322-page, spiral-bound *User's Guide and Reference Manual* and two diskettes. One diskette contains OPTASM; the other, OPTHELP (the on-line help system). The former contains a sample source program that reveals ambiguities in MASM and an include file showing how to use some features unique to OPTASM. The package has no installation program, but installation instructions in the *User's Guide* are clear.

The configuration program, CONFIG.COM, tailors the assembler to specific user needs. The 48 configuration settings fall into four major categories: code generation, MASM compatibility, ease of use, and listing control. Most MASM compatibility issues deal with changes in MASM from version to version, and others, with the sometimes unexpected or ambiguous behavior of MASM. Many settings can be overridden by other options or source code directives. Source code directives take precedence over command line options, which, in turn, take precedence over environment variable settings. Last in precedence are the configuration settings.

When numeric constants are written in assembly-language programs, the characters *B* and *D* can represent either hexadecimal digits or suffixes indicating that the number is expressed in binary or decimal. MASM treats a trailing *B* or *D* character as a radix suffix; developers can configure OPTASM to interpret the constant as either a normal digit or as a suffix.

Two schools of thought exist on control characters within text strings. If a text editor allows their easy entry, they can be conveniently embedded within strings of text characters. On the other hand, some like control characters to appear visibly in the listing—for example, by means of the constant 0CH or equated symbol LF. An OPTASM configuration setting allows programmers to have it either way.

In MASM, the OFFSET operator by default returns the distance of a label from the start of its segment. In OPTASM, a configuration option can alter the default to return an offset relative to the symbol's group.

OPTASM can be configured so that when it compares strings with the assembler IF directives, it disregards leading white space. MASM always compares strings literally.

MASM can produce unexpected results when generating PUBLIC directives in complex code sequences. For example, MASM generates L1 as a public symbol from the following sequence, when you would expect L2 to be public:

```
L1  EQU     7
L2  EQU     <L1>
    PUBLIC  L2
```

OPTASM can be configured either to duplicate the MASM behavior or generate L2 as public.

MASM deletes an ampersand at each level of macro nesting. OPTASM provides a setting to delete only when actually replacing a parameter.

OPTASM can be configured to flag as a syntax error the use of an OFFSET operator assigned with an equals sign. MASM often mishandles this. In the following example, MASM generates code to load the content rather than the address of X2 into AX:

```
X1 = OFFSET X2
MOV AX,X1
```

Prior to MASM 5.0, the immediate operands of AND, OR, and XOR were always the same length as the target; for 16-bit targets, that meant 16-bit operands. With 5.0 and 5.1, MASM exploits processor features that use sign-extended, 8-bit operands for 16-bit targets. Developers can configure OPTASM either way. The significance is that Intel did not document this format in early versions of processor specifications, so it was not implemented in some non-Intel versions of the chips.

OPTASM extends assembler syntax with several time-saving features. For a label that refers to multiple bytes of information, the LENGTH operator in OPTASM returns the total number of bytes identified by the label, whereas in MASM it returns the size of each elementary unit. In the following example, LENGTH STR returns 7 in OPTASM and 1 (the length of each unit associated with the DB directive) in MASM:

```
STR DB '1234567'
```

To determine string length in MASM, the programmer typically inserts an equate for $-STR immediately after the above line of code; OPTASM does this automatically. The TYPE operator in both returns information about size of each element at a label.

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If requested, OPTASM chooses call and unconditional jump instructions that generate the least number of bytes. The programmer is relieved of having to figure out from which operator to choose among SHORT, NEAR, and FAR. OPTASM automatically expands conditional jumps to an equivalent two-instruction pair when the scope of the jump is beyond the 128-byte limit. Again, the clerical work of programming is reduced. For example, JNZ XYZ is expanded as follows when XYZ is more than 128 bytes away:

```
  JZ    LOCAL
  JMP   XYZ
LOCAL:
```

If a load-effective-address (LEA) instruction references an unindexed operand, OPTASM can generate a faster move instruction (mov reg, OFFSET address) to load the target register. The PUSHM and POPM instructions are useful built-in macros that move multiple arguments to and from the stack.

OPTASM has predefined .TIME and .DATE equates for the assembly being done. Their values are in binary DOS format. The TND.INC file on the OPTASM diskette has macros to convert time and date into strings that can be embedded within object modules.

The /G command line option makes all symbols in a module global. This is handy for working with hardware debuggers that use neither a linker .MAP file nor an .EXE containing CodeView records. The /C command line option produces an ASCII symbol cross-reference table that programs can use directly. In contrast, MASM and TASM produce binary cross-reference information in a separate file; a post-processor utility then transforms this into a cross-reference listing.

The make facility also is integrated with the assembler. To use it, a developer constructs a dependency file similar to one used by a stand-alone make utility. This file is input to the assembler in place of a source file. It is not a full replacement for a make program because it does not address building a mixed-language program.

The documentation is unchanged from OPTASM 1.0; version 1.5 changes are listed in a READ.ME file. The single-volume manual begins with brief introductory and quick-start sections, followed by chapters describing the configuration and command-line options. Subsequent chapters describe source code syntax, instruction enhancements, data definition directives, structures and records, equates, segments, external symbols and code, conditional assembly, macros, and listing and output controls. Throughout these chapters, descriptions of OPTASM-specific features are surrounded by boxes to highlight them.

Besides printed documentation, SLR Systems provides an on-line facility called OPTHELP, which is based on the Peabody retrieval and display engine licensed from Copia International Ltd. When installed as a TSR, OPTHELP occupies 115KB, uses software interrupt 6AH, and cannot be unloaded from memory without rebooting. Configuration options permit changing the interrupt to any value between 60H and 7FH if a conflict arises with other software, changing the activation hot keys, customizing the display, and using OPTHELP in nonresident mode.

OPTHELP defines function key F1 for context-sensitive help about itself. It has a function to browse in directories, files, and memory and has indexes by both subject and key word for accessing the OPTASM information database. It has references for Intel processor instructions, assembler directives, and OPTASM command-line options. It also has panels that show operator precedence within OPTASM, definitions and usage of major interrupt vectors, and a chart of ASCII characters. SLR provides no hard-copy documentation for OPTHELP, but none is really needed.

TABLE 4: ***Assembler Performance Comparison***

	BORLAND TASM	MICROSOFT MASM	SLR SYSTEMS OPTASM
VDISK.ASM 2,274 total lines 2,186 source lines No include files			
CPU time	8.1	12.6	4.7
Disk time	7.4	9.2	5.5
Total time	15.5	21.8	10.2
.OBJ file size	4,252	5,652	4,132
PROGRAM 1 2,434 total lines 664 source lines 3 include files			
CPU time	10.6	9.5	4.3
Disk time	8.8	10.1	5.7
Total time	19.4	19.6	10.1
.OBJ file size	2,165	2,441	1,966
PROGRAM 2 23,568 total lines 5,184 source lines 19 include files			
CPU time	72.2	61.5	22.0
Disk time	31.6	26.7	21.5
Total time	103.8	88.1	43.6
.OBJ file size	13,118	16,288	12,449

All times are in seconds; sizes are in bytes.

SLR Systems' OPTASM is easily the fastest in all tests and produces the smallest output files. However, given the excellent performance of all three assemblers, the differences are significant only for the largest, most complicated programs.

EXECUTION EFFICIENCY

Speed of assembly is the primary measure of assembler performance. Also important is the size of the object file the assembler produces. In *PC Tech Journal*'s tests, OPTASM consistently outperformed the other two, with times 33- to 50-percent faster.

Three programs with different characteristics were used to test assembly speed under varying conditions on an 8-MHz PC Designs Turbo AT with 640KB of RAM and a Seagate 4038 hard disk (with average seek time of 40 ms and interleave factor of 2). All tests used DOS 3.3 using the FASTOPEN directory-caching program and were conducted with and without a 1MB disk cache (see table 4). Only results with-

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out the cache are reported because timings are consistent between cached and noncached tests.

Each test produced listing and object files. All of the source files were in the same directory, which contained 200 files. Consequently, directory search time was a significant but equal factor in all assemblies, particularly for those with include files.

The first test, VDISK.ASM, assembled the source for VDISK.SYS supplied with DOS 3.1. The source file, created by editing the VDISK.LST file supplied on the supplementary DOS 3.1 diskette, has 2,186 source lines (excluding comments), some small macros, and no include files. In this test, TASM was midway between OPTASM and MASM in elapsed time.

The second test assembled a public-domain TSR demonstration program (664 source lines and 3 include files) that relies on macros to generate much of its code. This test represents assembly of an average, well-structured assembly program. MASM and TASM were in a virtual dead heat, but were well behind the leader OPTASM, which ran the test twice as fast.

The third test assembled a proprietary TSR with 5,184 source lines and 19 include files. Macros generate most of the code. This program is a good test of assembling a large program that depends heavily on macros for code generation. MASM took twice as long as OPTASM to do the job, TASM 2.5 times.

Although less significant than actual assembly, object module size plays a role in performance because a linker can read a smaller object module in less time and does not spend as much time applying address fix-ups for forward references. Because OPTASM and TASM resolve forward references by reading source files twice, their .OBJ files are consistently smaller than MASM's. The size of object files is a minor point for simple programs of a few modules, but becomes important when many object files are linked together. A complex development project with a large library of object files generated by an assembler could save linking time over the project life simply by using the smaller .OBJs generated by OPTASM or TASM.

IN A PERFECT WORLD

Each product has compelling features: OPTASM is the fastest, MASM the most complete, and TASM's IDEAL mode has more structured syntax. MASM documentation slants toward Microsoft languages; TASM, toward the Borland brands. MASM documentation is superb in quantity, quality, and organization. TASM documentation has excellent examples and tutorials.

OPTASM has options that support its use with either Microsoft or Borland languages. MASM, together with the set of Microsoft utilities, is a self-contained environment for writing only in assembly language. The TASM package is nearly as complete. Developers can use any of these three assemblers with any high-level language that properly documents its calling protocol.

The listings that each assembler produces have some features that make each one useful in its own way. Both TASM and MASM show levels of macro depth. OPTASM annotates conditional jump and LOOP instructions with the full offset of the target, shown in parentheses (the machine code contains only a self-relative offset). All three assemblers have useful, but sometimes different, listing control directives.

Although it is flexible, the configuration of OPTASM presents a risk to fairly large and formal development groups. Different programmers can configure the assembler to suit individual tastes, thereby producing different output when the same source is assembled on different workstations. The straightforward solution is to standardize and enforce a single configuration of OPTASM for an entire organization.

The speed of OPTASM will be appreciated by advocates of incremental development. With this approach, programs are written and tested one procedure—or even a few lines of code—at a time. In a typical day with incremental development, a programmer can assemble, link, and test many, many times. After several dozen cycles over the course of a day, the one-minute difference between OPTASM and TASM for test 2 will loom large.

Compatibility with OS/2 is another consideration in choosing an assembler. Creating code that runs in protected mode is not the issue, because any assembler, running in either real or protected mode, can produce object code that an OS/2 linker can link into a protected-mode executable file. Nor is it a disadvantage that a real-mode assembler cannot be multitasked in the background with more productive foreground work. Most assemblies proceed so quickly that they are over before the user can switch to another session to start a useful parallel process. It is quite possible, therefore, to use any of these three assemblers in the real-mode box of OS/2.

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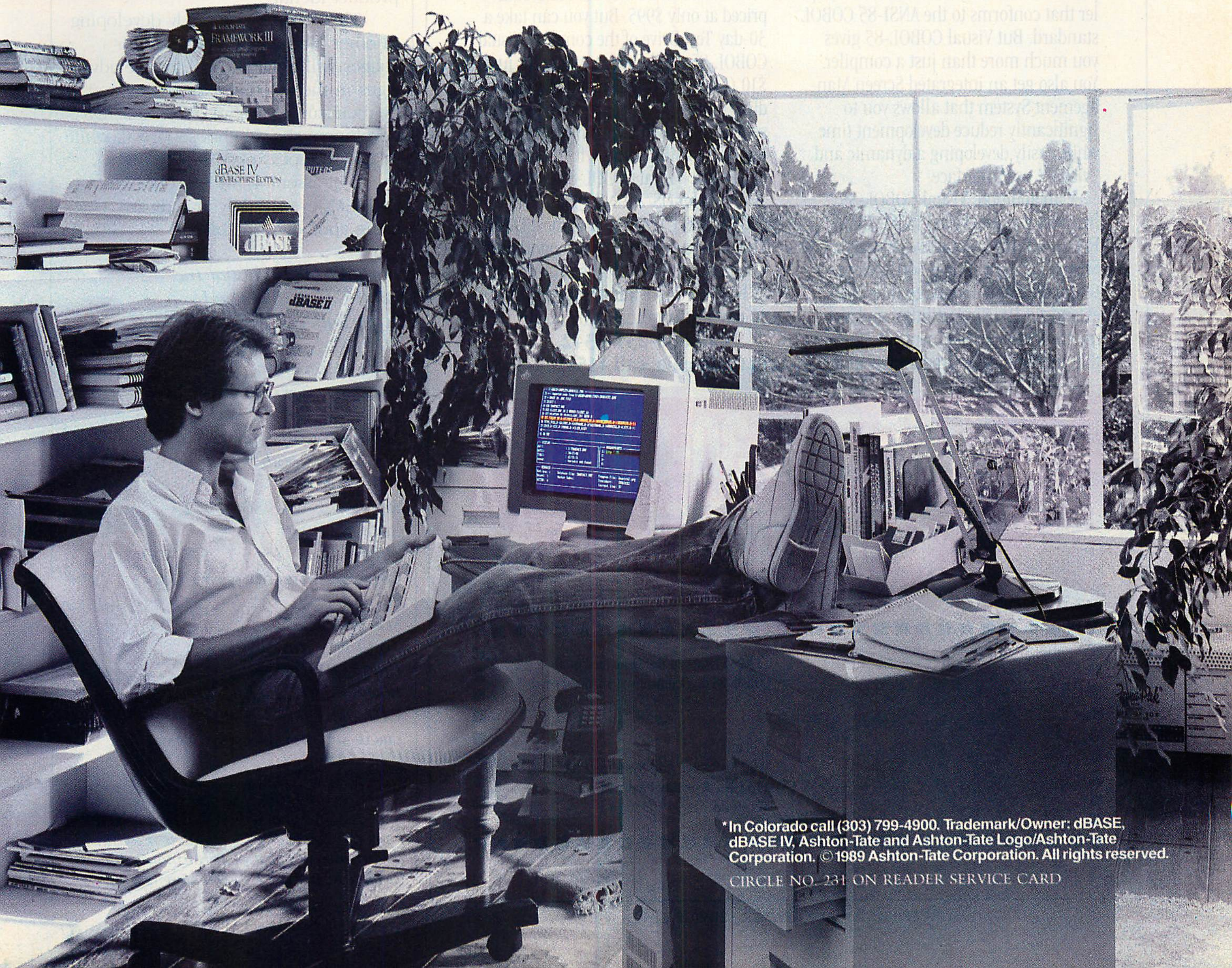

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Possible, however, is not the same as desirable. Because OS/2 supports only one real-mode session, it is undesirable for many programs to compete for session use. The more OS/2 tools a developer has, the fewer decisions are needed about which program gets use of the DOS box at a given moment. The developer can reserve the box for a DOS-mode text editor, word processor, or file-patching utility. Of the assemblers reviewed, only Microsoft's MASM executes in protected mode.

Which assembler is best for you? An understanding of the standardization efforts that govern the evolution of high-level languages provides the answer. Language standards keep people from getting locked into a single language implementation. According to that theory, it does not matter which assembler a developer uses, as long as all programs are limited to the subset of features common to all. In an ideal world, vendors would cooperate to implement compatible assemblers, but with standardization comes loss of product identity.

Those who are already developing in other Microsoft or Borland languages will find cost and feature advantages in the assembler that is offered by their current language vendor. OS/2 developers should choose MASM, while DOS developers needing the raw speed of assembly should opt for OPTASM, even if they already are using another assembler.

Borland International Inc.
1800 Green Hills Road
Scotts Valley, CA 95066-0001
800/543-7543; 408/438-8400
Turbo Assembler 1.0: $149.95
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Microsoft Corporation
16011 N.E. 36th Way
P.O. Box 97017
Redmond, WA 98073-9717
206/882-8080
Macro Assembler 5.1: $150.00
CIRCLE 346 ON READER SERVICE CARD

SLR Systems
1622 N. Main Street
Butler, PA 16001
800/833-3061; 412/282-0864
OPTASM 1.5: $125.00
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Ben Myers has, over the past 25 years, used and designed macro assemblers for many types of computer systems. He is a founder and owner of Spirit of Performance Inc., located in Harvard, Massachusetts.

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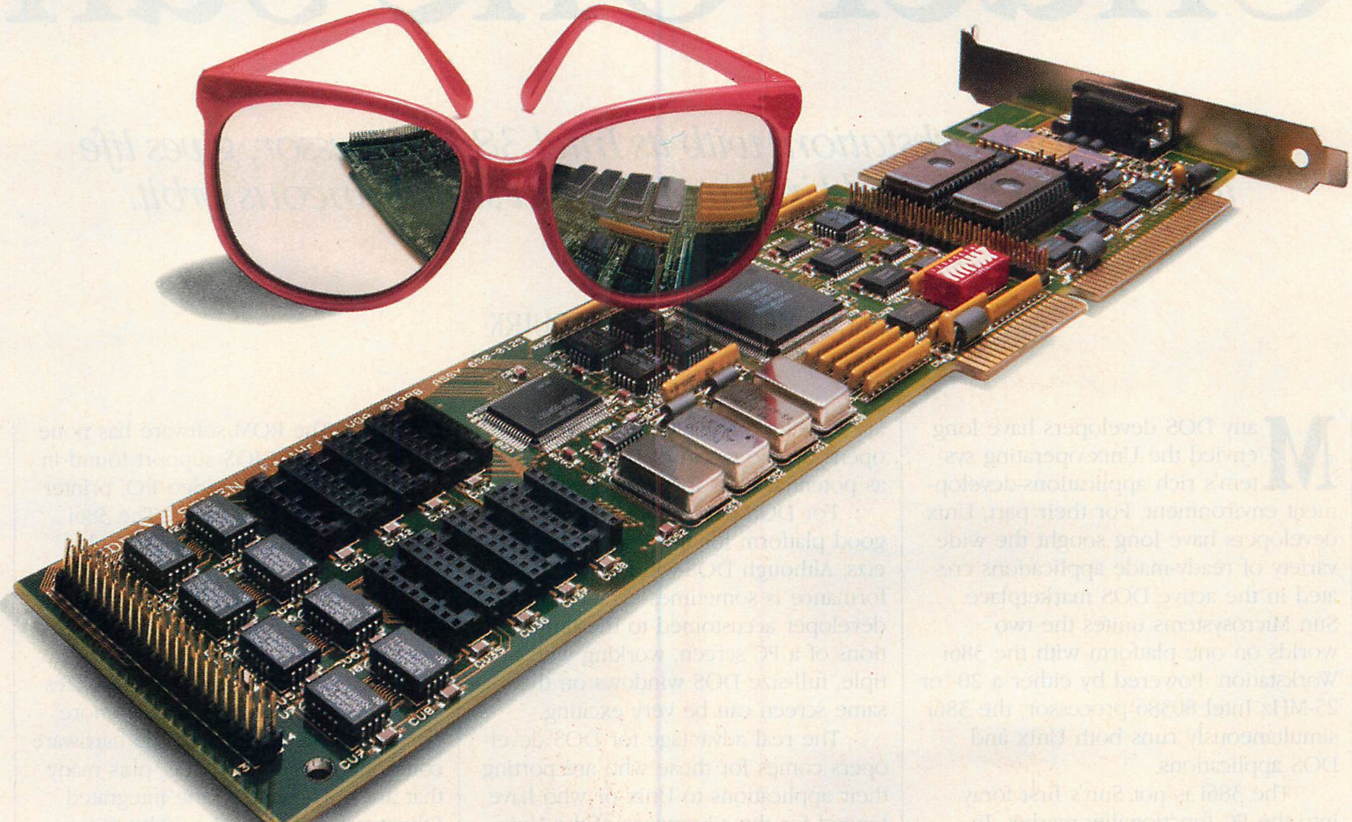

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Two Worlds Under One Sun

The Sun 386i workstation, with its Intel 386 processor, gives life to both the DOS and Unix worlds—in simultaneous orbit.

ALAN MOYER and KENT QUIRK

Many DOS developers have long envied the Unix operating system's rich applications-development environment. For their part, Unix developers have long sought the wide variety of ready-made applications created in the active DOS marketplace. Sun Microsystems unites the two worlds on one platform with the 386i Workstation. Powered by either a 20- or 25-MHz Intel 80386 processor, the 386i simultaneously runs both Unix and DOS applications.

The 386i is not Sun's first foray into the PC functionality market. In 1986, Sun introduced the Integrated Personal Computer (IPC) board for Sun-3 workstations. The IPC's 10-MHz 80286 permits a single DOS window to run within the Unix-Sun windows environment. Sun has taken this idea one large step further with the 386i. Instead of simply providing DOS functionality, the 386i runs both native-mode DOS and Unix applications.

For Unix developers, the 386i is a powerful, authentic implementation of Unix in the best Sun tradition—graphics capabilities and performance are excellent. Equally important, it opens up the world of DOS products as potential tools for Unix developers.

For DOS developers, the 386i is a good platform for many kinds of projects. Although DOS-window video performance is sometimes erratic, to the developer accustomed to the limitations of a PC screen, working with multiple, full-size DOS windows on the same screen can be very exciting.

The real advantage for DOS developers comes for those who are porting their applications to Unix or who have longed for the advantages of the Unix development environment. The 386i has a nearly seamless interface for moving between Unix and DOS applications—the end user does not need to know or even care which is which. Another benefit is the 386i's integrated Ethernet interface, which allows PCs and Sun workstations on the same network to share information.

One point must be made clear, however. Although the Sun 386i has a 386, it is a Sun workstation, *not* a PC. This distinction is evident at the fundamental levels of ROM support and hardware. The ROM software has none of the standard BIOS support found in a PC's ROM, such as video I/O, printer support, or disk interfaces. The 386i boots from a diskette in a pinch, but only to a Unix system monitor. The ROM cannot even read a PC-formatted diskette, so inserting a DOS diskette at boot time does not work.

The internal hardware differences between the 386i and a PC are more apparent. The 386i has all the hardware components found in a PC, plus many that are not—notably, the integrated Ethernet interface and a 32-bit video frame buffer (see figure 1, p. 100).

Aside from internals, several external features distinguish the 386i from a typical PC. The keyboard, a superset of the PC's keyboard, has a 10-key function keypad on the left side, reserved for Sun-specific functions. An additional horizontal row of function keys is located immediately above the number keys, and a Delete key is placed just above the Backspace key. The keyboard has identical connectors on each side, one for the keyboard cable from the system unit and the other for a mouse.

COMPUTER GRAPHIC • NATALE/EAST


25MHz
sun
PC Tech Journal System Benchmarks

In another departure from the PC world, an external light to indicate hard-disk activity is not provided. A faint clicking sound is the only indication that the disk is active.

FULL-BLOWN WORKSTATION

Although the 386i fits on a desktop, its size (20-by-16-by-8 inches) will prompt most users to attach the feet and stand it up next to a desk (see photo 1). The system comes in two models: model 150 has a 20-MHz 80386 and model 250, reviewed here, has a 25-MHz 80386 (see the sidebar below). Both systems come standard with 80387 coprocessors that run at the same speed as the 80386.

Sun offers a choice of several video displays. The resolution on the color models is spectacular—but it does not come cheap. A 19-inch color display and a 16-inch color display ($8,055 and $5,055, respectively) both offer 1,156-by-900-pixel resolution and 256 colors selected from a 24-bit palette (8 bits each of red, green, and blue). The company also offers a smaller 14-inch, 8-bit color display that supports 1,024-by-768-pixel resolution, and a 15- or 19-inch 1,152-by-900-pixel monochrome display.

Support for the SCSI standard for the disk drives is on the system board. The system unit accommodates either a 91MB or 327MB 5.25-inch full-height hard disk (see photo 2). An additional SCSI connector on the back panel supports additional drives.

The system board has eight slots for add-in boards: four Sun-proprietary 32-bit slots, three 16-bit AT-compatible slots, and one 8-bit XT-compatible slot (see photo 3). The video frame-buffer board occupies the one Sun slot accessible from the rear panel. All system RAM (a minimum of 4MB is required, expandable to 16MB) is located on an expansion board plugged into a proprietary 32-bit bus connector. The board contains an Intel 82385 cache-controller chip and 32KB of zero-wait-state cache RAM (see photo 4). A cache miss costs six wait states. The user can add memory in standard 1MB single in-line memory modules (SIMMs).

A slower dynamic-RAM board with page-mode RAM and no cache is optional. The pages are 1,024, 32-bit words long and require three wait states for the first access to a new page and one wait state thereafter.

The video frame-buffer board supports all of the video formats and contains 1MB of 32-bit RAM for the frame buffer and a Brooktree video digital-analog converter supporting 256 colors from a 24-bit palette (see photo 5). A three-button, 200-dots-per-inch resolution optical mouse manufactured by Mouse Systems is standard with the 386i. Unfortunately, the reflective pad for the mouse is too small. Some Sun insiders say they use mechanical mice with the system, although it may be difficult to get a mouse with the appropriate eight-pin connector.

Some hardware commonly found on PC systems is emulated on the 386i. The optical mouse, for example, can be switched between Sun mouse emulation and Microsoft mouse emulation (which is restricted to the DOS window). The two left-most mouse buttons then act like the Microsoft mouse buttons, and the right button continues to bring up Sun menus.

The 386i also emulates expanded memory. An EMS 4.0 driver supporting up to 32MB of expanded memory is part of every DOS window. The expanded memory is implemented as virtual memory on a Unix file.

System software provided with the 386i is the Sun Operating System (SunOS). SunOS is based on two standard versions of Unix, System V release 3 and BSD 4.2 and 4.3. SunOS 4.0.1 was evaluated in this review.

GLOSS AND POLISH

The 386i user interface, SunView, is an inviting windowing system, particularly when viewed on the high-resolution 19-inch displays. Consistent and attractive, it shares many features of the Macintosh and Microsoft Windows.

Differences between SunView and other windowing systems are minor, but initially may prove troublesome to developers accustomed to the Macintosh or to Microsoft Windows. The scroll bars on the 386i, for example, work in reverse from other windows-based software. The Sun scroll bars move the window rather than the text inside the window. Thus, clicking the mouse on the Up box moves the window up and the text down.

Other differences related to the capabilities of SunOS are welcome. Because the 386i has true multitasking capabilities, a closed window (represented by an icon) can continue to run until the program requires user input. A developer can, for example, start a compile, close the window, and then start another application while the compile continues. Because SunView supports overlapping windows, an alternative to closing a window is to open another window over the first.

Manipulating the windows is easy because they behave as expected. When the user moves the mouse pointer into a window, the system directs all keyboard and mouse input to that window. The mouse button accesses different features depending on the application, but more often than not it pops up a menu. Menus pop up at the pointer location, with the most recent selection highlighted.

If a menu selection has a submenu, a small arrow pointing to the right follows the selection. Placing the mouse pointer on the arrow displays the submenu (clicking the mouse is not necessary). When a menu selection requires a confirmation, a dialog box pops up and the pointer moves to the default answer. Initially, this automatic pointer movement may bother PC users who instinctively try to move the pointer to the menu, not realizing that the pointer is already there.

SUN 386i VITAL STATISTICS

Model 150: $7,490
20-MHz Intel 80386 microprocessor
4MB memory
20-MHz Intel 80387 math coprocessor
Realtime clock
Serial port, parallel port
Optical 3-button mouse
SCSI support
10-Mbps Ethernet interface
1.44MB 3.5-inch diskette drive
107-key keyboard
SunOS with integrated MS-DOS 3.3

***Model 250: $11,045**
Same features as above except with 25-MHz 386 and 387, plus 32KB SRAM memory cache, Intel 82385 cache controller, and 8MB of RAM

Available options:
4MB, 80-ns memory SIMM kit: $3,400
4MB, 100-ns memory SIMM kit: $3,400
*19-inch color display: $8,055
16-inch color display: $5,055
14-inch color display: $3,300
19-inch monochrome display: $2,780
15-inch monochrome display: $1,650
*VGA board: $895
91MB SCSI hard-disk drive: $2,200
155MB SCSI hard-disk drive: $4,125
*327MB SCSI hard-disk drive: $6,600
Peripheral expansion unit with 60MB tape backup unit: $2,200

An asterisk indicates the model reviewed and the options included.

PHOTO 1: ***Sun 386i with 19-inch Display***

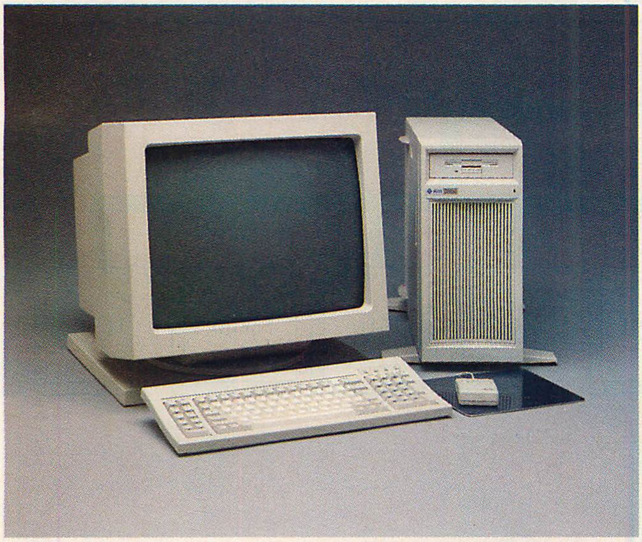


PHOTO 2: ***Inside the System Unit***

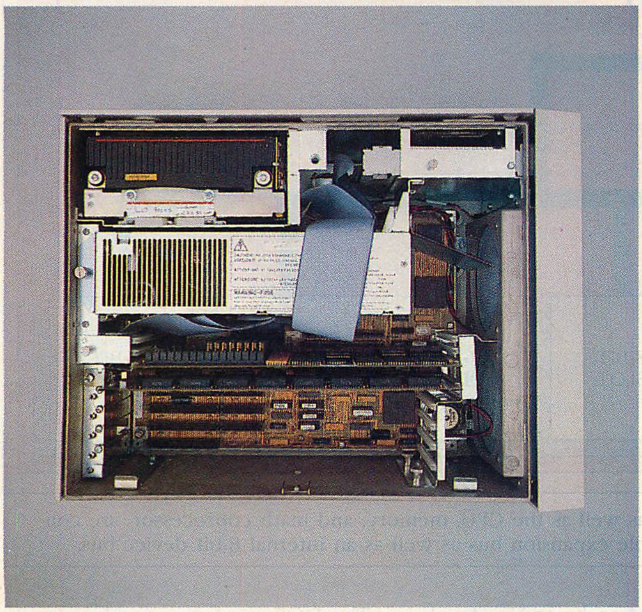


Photo 1: The 386i system unit is dwarfed by the 19-inch high-resolution color monitor; optical mouse is standard.

Photo 2: The system unit accommodates one hard drive (top left) and one 3.5-inch, 1.44MB diskette drive (top right). The power supply is in the center of the unit.

Photo 3: The Sun 386i system board holds the Intel 80386 processor and 80387 math coprocessor and accepts Sun-proprietary 32-bit and AT-style expansion boards.

Photo 4: Because the single in-line memory modules (SIMMs) are perpendicularly placed, the system memory board takes up two slot spaces, leaving one slot unusable.

Photo 5: The video frame-buffer board contains 1MB of 32-bit display memory. The single connector on the rear bracket drives the keyboard, mouse, and video display.

Photo 6: The Sun VGA board with its additional 1MB of RAM, developed jointly with Video Seven, displays VGA images on the 386i Workstation's display screen.

PHOTO 3: ***System Board***

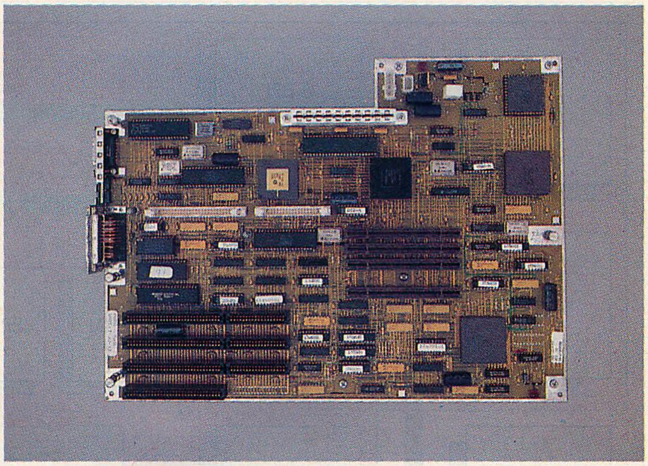


PHOTO 4: ***System Memory Board***

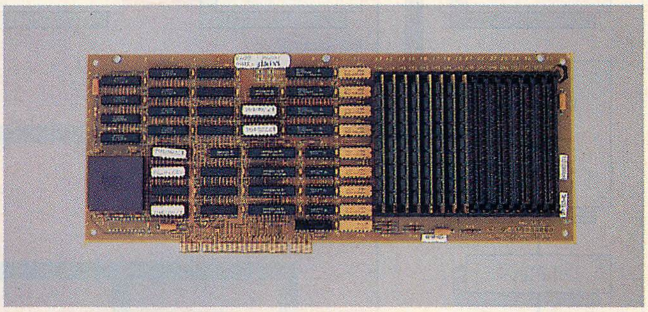


PHOTO 5: ***Video Frame-buffer Board***

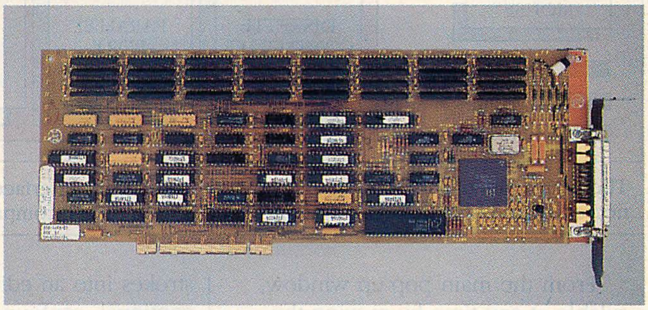


PHOTO 6: ***Sun VGA Board***

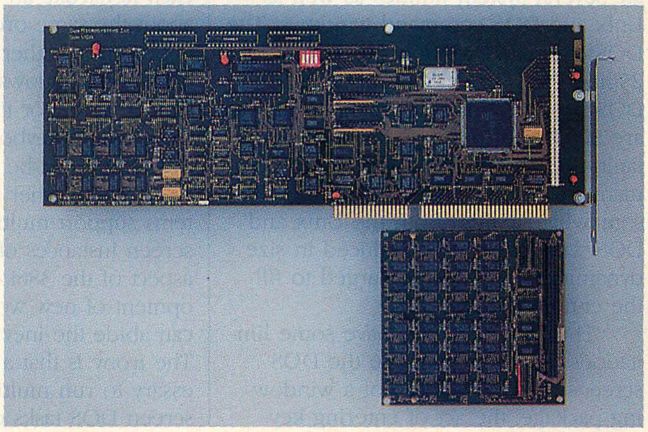
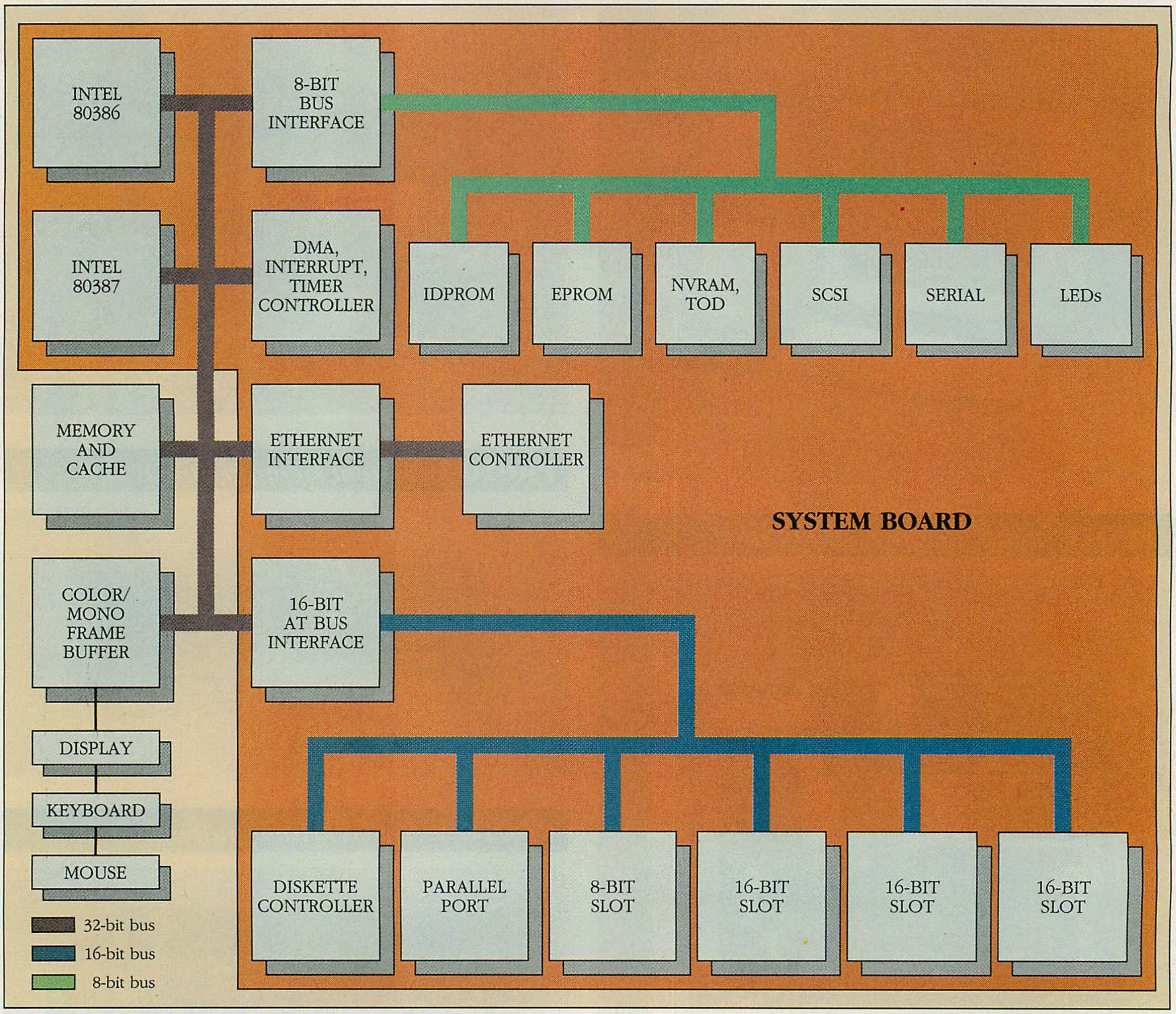


FIGURE 1: *Sun 386i Architecture*



Adapted from Sun Microsystems' Sun 386i Overview: A Sun Technical Report

The 386i's video frame buffer and integrated Ethernet interface, as well as the CPU, memory, and math coprocessor, are connected by a 32-bit bus. The system includes a 16-bit AT-compatible expansion bus as well as an internal 8-bit device bus.

From the main pop-up window, available at any time by moving the pointer outside any open windows and clicking the mouse, the user can initiate several system utilities as well as Unix and DOS command windows. The DOS command window is a complete 25-line DOS screen with the familiar DOS prompt; Unix command windows are 80 characters by 33 lines. By default, the Unix window is as large as many PC displays; the DOS window is somewhat smaller. Both the Unix and DOS windows can be reduced in size dynamically and even enlarged to fill the entire 386i screen.

The DOS windows have some limitations, however. Because the DOS screens are built on top of a windowing package, the act of entering keystrokes into an editor can be trying. A continual, confounding hesitation between the fingertip initiating a key press and the eye confirming it makes each keystroke an event. The delay is about the same order of magnitude as is present in other windowed editors; Microsoft Windows-Write operates at a similar pace. For those who are more facile with a keyboard than a pencil, this tempo can be maddening.

On the other hand, not many systems support multiple concurrent full-screen instances of applications. This aspect of the 386i could enable development of new work habits, if the user can abide the inevitable sluggishness. The irony is that a Unix system is necessary to run multiple full-screen onscreen DOS tasks concurrently.

The DOS window is implemented in the 386i's virtual-86 mode. In this mode, each DOS window acts as if it owns a complete 640KB IBM PC-compatible computer. The processor has a memory space equivalent to an 8086, but can execute most of the nonprotected-mode instructions that Intel added to its 186, 286, and 386.

In particular, software running in a DOS window can use 32-bit math, although any software attempting to use protected mode (such as Borland International's Paradox 386, IGC's VM/386, or Qualitas Software's 386-to-the-Max, and, of course, OS/2) will fail. Applications also can use the 387, which is standard on the 386i. The Unix system maintains the correct coprocessor state across task switches.

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PC-compatible hardware is either allocated (from among any real hardware devices in the 386i's expansion slots) or emulated (in the case of disk, video, and keyboards). A complete AT-compatible BIOS from Phoenix Technologies is mapped into the appropriate addresses in each DOS virtual machine. To prevent contention, the user must describe any hardware devices that have been added to the system in a file called BOARDS.PC. This file contains details such as I/O addresses and memory space used, interrupt numbers, and direct memory access (DMA) channels needed.

The user can allocate a board or device to only one DOS window at a time. The allocation routines also work with the diskette drive. Rebooting the window that controls drive A: causes that window to attempt to boot from the diskette drive. If a bootable disk is present, it works. Even though a version of MS-DOS 3.3 optimized for the 386i is included as part of the 386i's licensed software, other versions can be loaded, if desired.

Video is emulated and handled remarkably well given the constraints within which it must operate. Periodically, the task handling a DOS window is interrupted and has to compare a saved image of the DOS screen with the current (emulated) image. It then makes calls to the SunView window manager to draw a new DOS screen image in graphics mode, with windows, clipping, and so forth. This requires many CPU cycles, which can result in sluggish video performance.

When an application program attempts to change the video mode (say, from text to graphics), either in hardware or through a BIOS call, the attempt is trapped. The DOS task then figures out the effect of the requested change, redraws the SunView window with a new configuration, and draws the graphics into the DOS window.

A DOS access to a CGA hardware port (to check for vertical interval, for example) is trapped by the 386's memory-management hardware and routed to the CGA simulation software. The simulator determines the state in which a real CGA would be and returns the appropriate value to the DOS task. A single 8086 instruction, such as a port read, can be simulated by tens, hundreds, or even thousands of 386 instructions.

Video updates work in a similar fashion. Each write to video memory causes the system to trap and mark a region of the video buffer as "dirty." Periodically (10 to 20 times a second), the system examines the dirty bits and redraws the screen areas affected.

This, then, explains why the DOS video performance is so erratic. The act of drawing a character or an image into a DOS display has no direct relationship to the appearance of that character on the screen—it happens at the next timer tick instead. The result is that scrolling, animation, and fast-typing performance suffers, all of which assume that a direct relationship exists.

In addition to slightly higher performance, the Sun VGA board, examined in beta release (see photo 6), provides more colors and higher resolution for DOS windows. A register-compatible VGA jointly designed by Sun and Video Seven, the Sun VGA board has the unusual distinction of being the only known video board that contains no video outputs. Rather than video drivers, the board contains an extra megabyte of RAM and hardware to perform high-speed comparisons of screen images.

Instead of sending video output to a display, the board runs a video-speed comparison of the VGA-generated image with the previous image stored in RAM. The CPU then updates regions marked as different to the Sun video buffer. The initial release supports one VGA image; according to Sun, a future version will support four VGA images from one board.

The beta version of the VGA board has the same minor compatibility flaws as the Video Seven board reviewed in "The VGA Parade" (Kent Quirk, January 1989, p. 70). Whenever the board changes to a different video resolution, the window on the SunView screen changes dimensions accordingly. The board has the same fonts and colors as a normal VGA; applications such as RIX VGA Paint run well in a DOS window.

RISING SUN

Sun Microsystems was founded in 1982 to develop engineering workstations with powerful graphics and networking capabilities. Today, Sun is a dominant force in Unix workstations. The company's systems are based on the Motorola 68000, SPARC (Sun's RISC architecture), and, with the 386i, the Intel 386. The design automation/manufacturing and computer-aided systems engineering (CASE) markets made up roughly two-thirds of the company's fiscal-year 1988 revenues of $1.051 billion.

The company's business is not limited to the traditional workstation market. Sun workstations are being used in increasingly diverse application areas. According to the company, the artificial intelligence and scientific research markets accounted for 12 percent of its business. Markets targeted for increased attention include finance, imaging, earth resources, biomedical, and biotechnology applications, which accounted for more than 10 percent of revenues.

Although well-known for its hardware, Sun has been very active in developing software standards, with a heavy focus in the areas of Unix, graphics user interfaces, and networking. Recent joint announcements with AT&T have assured Sun a partner's role in the future of Unix standards and development (even discounting Sun's substantial Unix system base).

The most widely accepted of Sun's attempts at standards may be the Network File System (NFS). Sun has implemented, and released as a public standard, a protocol for network access that fosters the sharing of resources by dissimilar systems. NFS includes Remote Procedure Call (RPC) mechanisms that contain a protocol for translating data representation between systems (called XDR).

Sun is similarly involved as a central player in the area of graphics user interfaces. Sun has long proposed its own Network-extensible Windowing System (NeWS, now X11/NeWS) as an industry standard and features prominently in the evolution of X Window and AT&T's Open Look. SunView, the 386i workstation's graphics user interface, was first released with SunOS 3.0.

Recent, more controversial work on standards at Sun includes development of a standard application binary interface (ABI) for Unix. This standard would allow vendors to produce executable binaries compatible with all conforming systems from within the same processor family and from any Unix system vendor. This work is being done in conjunction with AT&T as part of the current round of Unix development.

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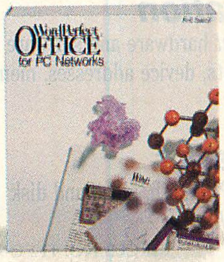

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One of the big advantages of the DOS window is its ability to emulate either color or monochrome video modes. Because multiple DOS tasks can run concurrently, the system can simultaneously display the same program running in several different video configurations. This is a big advantage for software developers trying to make a program visually appealing.

ONE WORLD

Sun has gone to great lengths to provide interoperability between DOS and Unix. The company has gone so far as to make it possible to run DOS and Unix programs from either environment. Both operating systems can participate in the same pipe; DOS programs can initiate Unix programs and vice versa. A certain portion of the Unix file system is even part of the default path for DOS. For example, the **dir | grep** command sequence invokes the DOS DIR command and pipes the result to the Unix **grep** command.

Both the DOS and Unix paths are used to resolve executable references. The Unix **make** utility can invoke DOS language compilers. The source-code control system can be used to manage DOS sources. Similarly, the developer can use DOS tools to operate on Unix software. The 386i provides a unique environment that has many of the attributes of a cross-development toolkit, but with some fascinating twists.

DOS and Unix tasks can communicate in many different ways. DOS programs can use shell command-line and named pipes, and SunView permits the user to cut and paste between DOS and Sun windows. Unix programs can read DOS files and vice versa. Most of the DOS disk drives are simply pointers to locations within the Unix directory structure; these drives can be located even across a network on a different machine.

DOS drive C: is a software emulator that uses a single Unix file as the data space; this provides sector-level disk compatibility for copy-protected software. Programs such as the Norton Utilities also work on this drive. Because Unix tasks cannot read this disk file, Sun recommends that it be used only when necessary.

The 386i's **dos2unix** and **unix2dos** utilities, for converting between DOS and Unix text file formats, are just as convenient as copying from one device to another (Unix uses only line feeds to mark the end of a line; DOS uses carriage return/line feed combinations). Of course, DOS and Unix toolkits use different object-code specifications. A program built with DOS tools will work only with DOS tools and can be run only in DOS. The same is true for Unix tools and applications.

EASY TRANSFERS

To gain some insight into how effective these system tools are for porting DOS-based software to the 386i, three programs from the *PC Tech Journal* System Benchmarks (HLDISK, HLFLOAT, and HLSORT) were ported to Unix (see "High-level Benchmarks," Kent Quirk, September 1988, p. 54). HLDISK performs disk I/O to measure disk performance, HLFLOAT performs a Fast Fourier Transform (FFT) on a large quantity of data, and HLSORT performs an in-memory sort of an array as a test of CPU speed.

Overall, porting these programs to the 386i is relatively easy. Some of the C header files and a couple of functions have different names from the ones Microsoft uses; the ANSI C standard will likely correct this. The system-level functions (such as the clock) are quite different; the timing routine requires a conversion.

The prototyping features of ANSI C are missing; this means converting all of the headers to the original C style. The Unix **awk** program performs this job and is useful on larger projects. For smaller jobs, such as this one, editing the files is sufficient.

The port of three text-based programs took only a few hours. Porting any graphics portion of the programs would have taken a couple of days because no straightforward relationship exists between SunView and Microsoft C graphics.

Programming for SunView shares some paradigms with programming for the Macintosh, Microsoft Windows, or OS/2's Presentation Manager. A SunView application resides in one or more windows and becomes event driven; the system passes external events such as mouse clicks, mouse motion, and keyboard input to a program as they occur.

The program must deal with the input in whatever order it arrives. Other events might include opening, closing, or resizing a window. A SunView program must be prepared to deal with all of these events.

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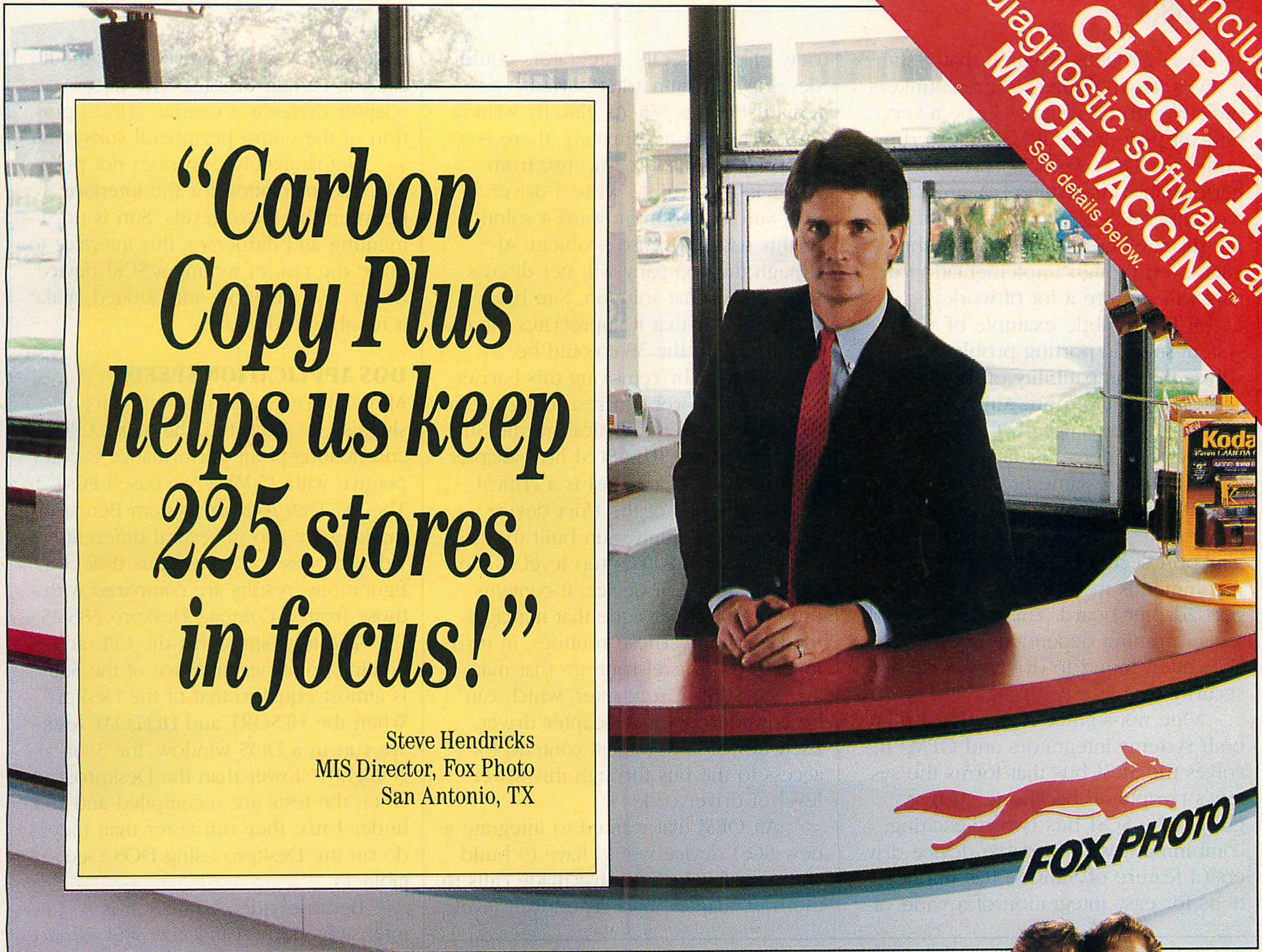

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CIRCLE NO. 230 ON READER SERVICE CARD

A large DOS program that assumes it owns its whole machine and tinkers directly with hardware will be a very difficult port; it should be left to run under the DOS window (even though performance may suffer). A program written for OS/2, Windows, or the Macintosh may be easier to port to the 386i, even though implementation details will require a lot of work.

A fairly subtle example of a system-specific porting problem involves the compatibility of the 386i's on-board parallel port. Although functionally a Centronics port with an IBM connector, it does not necessarily respond with the same timing as a standard AT port. In most cases, this is not a problem. If an application uses a parallel-port security device, however, Sun recommends installing an AT parallel-port adapter board. This prevents problems in timing dependent code, such as is often found in drivers for these security devices.

One not-so-nice realization for both systems integrators and OEMs involves the SCSI bus that forms the system's peripheral backbone. At first glance, the SCSI bus is very exciting; combining it with loadable device drivers (a feature of SunOS) has implications for easy integration of a wide variety of peripherals. Integrators could develop vertical-market, turnkey systems using the 386i as glue by writing SCSI drivers. Unfortunately, there is a catch—a Unix source license from AT&T is required to write a driver.

Sun is working toward a solution to this source-license problem. Although the company will not discuss the form of that solution, Sun has made it clear that it appreciates the extent to which the 386i could be strengthened by removing this barrier.

Another problem restricting use of the SCSI bus is a technical hurdle Sun must overcome. The SCSI host adapter (and the bus, of course) is a critical resource for all of the Unix device drivers. Accordingly, Sun built the drivers in two levels. The top level is specific to each SCSI device; it contains the normal driver code that manages the peripheral. These routines, in turn, invoke lower-level routines that manage the SCSI host adapter, which can be considered a host-adapter driver. Each device driver must contend for access to the bus through this lower level of driver code.

An OEM that wanted to integrate a new SCSI device would have to build an upper-level driver that made calls to the host-adapter level. The lower-level code cannot be circumvented without causing certain disaster. The host-adapter driver is a central, critical portion of the entire peripheral subsystem.

Unfortunately, Sun does not publish documentation for the interface between these two levels. Sun is documenting and hardening this interface to make the task of writing a SCSI device driver less daunting, and, indeed, make it feasible to do so.

DOS APPLICATION SPEED

Although DOS video performance is sluggish, as expected, the 386i's CPU and floating-point performance is competitive with 25-MHz 386-based PCs. The *PC Tech Journal* System Benchmarks were run in several different video modes and on various disk configurations; results are compared with those from a Compaq Deskpro 386/25.

The tests show that the CPU and floating-point performance of the 386i is almost equal to that of the Deskpro. When the HLSORT and HLFLOAT tests are run in a DOS window, the 386i is slightly slower than the Deskpro; when the tests are recompiled and run under Unix, they run faster than they do on the Deskpro using DOS (see table 1).

Because video emulation is so CPU intensive, the best that the 386i can do in terms of DOS video performance is to run as fast as an EGA-equipped IBM AT. Even worse is the overhead needed to keep an up-to-date screen when using DMA; the window/scrolling test takes four times as long as it does on the relatively slow AT (see table 2).

To be fair, most applications that support DMA for video do not need to scroll the screen very often; that is, real applications might perform acceptably. After all, six times slower than "too fast to see" might still be "too fast to see."

Unfortunately, video performance is more critical in the case of at least some text editors. Using Microsoft Word under SunOS 4.0.1 is still difficult. Because Word does its own keyboard handling, the system may miss keys that are struck quickly (for example, the second letter in a repeated letter sequence, spaces following words, or the letter *h* in the word *the*). This is a problem only for a fast typist (above 60-80 words per minute).

The system also cannot keep up while a key is repeatedly held down. Long-distance cursor moves become a wild guess or finger exercises. It does not matter whether graphics or text mode is used; the problem arises while updating the screen.

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CIRCLE NO. 161 ON READER SERVICE CARD

TABLE 1: ***CPU and Floating-point Benchmarks***

	IBM	COMPAQ	SUN	SUN	
MODEL	PC/AT 339	Deskpro 386/25	Model 3/50	386i Model 250	
OPERATING SYSTEM	DOS	DOS	Unix	DOS	Unix
EQUIPMENT					
Processor type/speed (MHz)	80286/8	80386/25	68020/15	80386/25	80386/25
Coprocessor type/speed (MHz)	80287/5.33	80387/25	68881/15	80387/25	80387/25
Memory cache size (KB)	N/A	32	N/A	32	32
HLSORT (CPU/memory)					
Data generation	2.08	0.54	0.60	0.54	0.49
Memory sort	23.02	5.71	6.81	6.15	4.56
Total	25.10	6.26	7.41	6.70	5.05
HLFLOAT (Fast Fourier Transform)					
Forward	18.13	2.58	4.56	2.91	1.86
Reverse	17.58	2.52	4.56	2.91	1.75
Total	35.71	5.10	9.12	5.82	3.62

All times are in seconds, converted from 18.2-Hz timer ticks; therefore, total displayed is not always the exact sum of the individual results displayed.

The CPU/memory and floating-point benchmark programs run 10 to 20 percent slower in a Sun 386i DOS window than on a Compaq Deskpro 386/25. Unix versions of the tests, however, run 20 percent faster on the 386i than on the Deskpro.

The VGA board should help to alleviate this problem, although the performance of the beta version was only slightly better than that of the existing DOS windows. Sun engineers claim that it will improve dramatically in the next few months. Aside from this future release, another way to increase performance is to install a PC-compatible video board, connect a separate display to it, and configure the system to recognize it. A DOS window can then use this board for video output instead of emulating it on the SunView screen.

Although the video performance was expected, the disk benchmarks yield some interesting results, some of them quite unexpected (see table 3). Surprisingly, disk performance is worse when using the Unix file system directly than when using the emulated DOS drive. This is because DOS considers the Unix drives to be network drives; these drives are not buffered internally by DOS.

Every disk read from a Unix drive is therefore an actual request to the Unix system for file information. The emulated drive (C:), on the other hand, is considered to be a local drive. DOS can and does buffer it, and thus achieves a good performance benefit. Sun still recommends that drive C: be used only for programs that require it, such as copy-protected applications.

EASE OF USE

Setting up and using the 386i is not difficult. Anyone who has installed a Unix system of any type before will have no problem. Those who have never done more with a DOS installation than use the /S switch when formatting a diskette, however, will want to read the setup and installation manuals carefully.

Starting the 386i installation process is easy—Sun delivers the system preloaded with a complete Unix environment on the hard disk, which is convenient. Although Sun also provides a complete set of diskettes and instructions for installing Unix, it is not a pleasant process and most users will never need to experience it.

During installation from the hard disk, the user must make several decisions about system setup. The biggest choice is whether to run the system as a network node or as a stand-alone computer. The user can change this decision only by reconfiguring the system, which removes all user software from the machine.

Unlike many DOS systems with a set-it-and-forget-it design, the 386i requires system management. A system administrator must maintain user accounts, back up the hard disk, and keep the network up to date. A Sun utility called System and Network Administration Program (SNAP) handles these items easily. As Unix systems go, this one is very intuitive.

Anyone expecting to use SNAP should use it and nothing else. SNAP is protective of its data file formats and refuses to work with files modified using other administration programs. For experienced Unix administrators who want to use other tools to manage system resources, however, SNAP can present a conflict.

As a multitasking system, Unix is known for having a file system that is sensitive to power failures and other natural disasters. SunOS addresses some of the causes of this problem. Much of the 386i's fairly long start-up time is spent performing a rather complete check of file-system integrity. SunOS fixes errors if possible. Because errors can be introduced by abruptly shutting the system down, most users will want to leave the system on most of the time.

With such a sensitive file system, backups are important. The only removable media standard with the 386i is a 1.44MB diskette drive—not exactly the best medium for backing up large quantities of information. Sun recommends that one machine on each network be equipped with a 60MB streaming-tape drive for backup use.

The 386i's powerful file-organizing application, called The Organizer, is a graphical directory browser that runs in a Unix window. The user invokes Organizer dialog boxes that offer services related to the directory or files on display using on-screen buttons or from the keyboard. For example, Copy performs a point-and-shoot file copy. PROPS displays a dialog box with information about a file such as file size and ownership.

The Organizer tags individual files with icons that quickly identify the type of file. For example, a Unix executable

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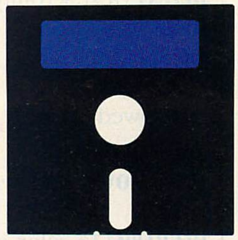

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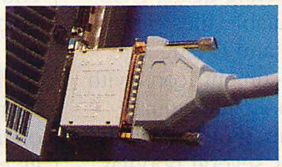

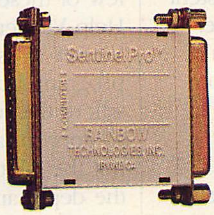

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TABLE 2: ***Video Benchmarks***

	IBM	COMPAQ	SUN		
MODEL	PC/AT 339	Deskpro 386/25	386i Model 250		
VIDEO CONTROLLER	8-bit EGA	16-bit VGA	CGA emulation	HCG emulation	Sun VGA
HLTEXT (text scrolling)					
BIOS	26.37	3.68	45.93	44.50	19.89
DOS	29.67	4.39	12.74	12.63	10.65
C library	23.46	3.79	42.69	42.96	31.37
Windowed	12.08	1.53	41.42	44.34	19.50
Total	91.59	13.40	142.80	144.45	81.42
HLWINDOW (window/scrolling)					
Total	17.52	2.41	63.40	64.39	50.98
HLGRAPH (16-color graphics)					
400 small areas	5.98	3.40	2.58	1.59	28.13
100 large areas	3.73	2.41	2.69	1.42	19.67
400 small ellipses	9.83	2.41	2.25	6.09	6.81
200 large ellipses	9.50	2.25	2.85	8.24	8.95
4,000 short lines	6.53	2.03	2.03	4.06	8.46
2,000 long lines	5.76	1.86	2.14	5.38	9.94
General graphs	1.37	0.54	0.21	0.65	2.41
Total	42.74	14.94	14.78	27.47	84.39

All times are in seconds, converted from 18.2-Hz timer ticks; therefore, total displayed is not always the exact sum of the individual results displayed.

Even using the optional Sun VGA board, text scrolling on the 386i is more than six times slower than on a Compaq Deskpro 386/25. Graphics operations also are slow on the 386i, except when using the 320-by-200-pixel CGA emulation mode.

file has an icon depicting gears, DOS command and executable files carry icons depicting PCs, and C language source files have document icons with indented text that looks like source-code format. The Sun 386i system also comes with icons for several popular applications. A Lotus 1-2-3 logo, for example, is available for representing Lotus spreadsheet files.

Double clicking on a file icon starts either a DOS or Unix application. Double clicking on a file name-tagged with the Lotus 1-2-3 icon, for example, opens a DOS window, starts 1-2-3, executes the Lotus /FR command, and automatically enters the file name.

The user can customize defaults, such as the programs executed or the icon for the file types, as well as much of the operation of The Organizer by changing parameters in the home directory's .ORGRC file. This is analogous to mechanisms present in Microsoft Windows but much more powerful. The *Advanced Skills* manual (included with the base system) contains instructions on how to define file types and customize The Organizer.

The user also can create icons with a bit-map editor called ICONEDIT. This tool is a pixel editor with some nice surprises. The user, for example, can browse through existing icons to select the one to edit. An enterprising end user thus is equipped with a graphics tool that few other systems offer even as an option.

This aspect of The Organizer is even more interesting from the developer's perspective. The Organizer and its environment provide developers with a simple way to achieve a unique appearance while remaining consistent with the system's standard interface. Some applications conceivably could use The Organizer as a primary component of their user interface.

ABUNDANT HELP

Several types of help facilities are available on the Sun 386i. The user can access information about almost any feature on the screen merely by pointing to the item with the mouse pointer and pressing the Help key. The system displays a single window of context-sensitive information.

An even more helpful utility is a stunning program called Help Viewer, a visually attractive on-line manual. Implemented as hypertext, Help Viewer looks like a typeset manual with graphics. Any underlined word or phrase in the manual is a pointer to another page that explains the concept further. Pointing to the underlined text and double clicking the mouse immediately displays that page. Pressing the Delete key returns to the original page.

Help Viewer contains manual text on using the system, The Organizer, the electronic-mail system, SNAP, and DOS windows. Unfortunately, the documentation in Help Viewer is less than complete. The text editor, for example, has a whole host of keyboard equivalents for mouse menu picks, but only a few of these are documented in the Help Viewer. The result is that Help Viewer is useful for learning a new program, but for advanced needs—where the hypertext features would be so appropriate—it falls short. This is not the fault of the application, but of the depth and completeness of the hypertext implementation.

For help on specific Unix applications, the standard Unix **man** command is available. The command **man grep**, for example, displays the **grep** manual text on the screen.

Developers can extend both the Help key and the Help Viewer program to include their own applications. Help Viewer applications can be created using the Interleaf Publisher or Frame Technology Corporation's Framemaker, which are available separately; the **man** program uses documents created for the Unix **nroff** text formatter. The Help key uses ASCII text files. Developers will appreciate this standard help support; they will also make regular use of the **man** pages during development.

TABLE 3: ***Disk-performance Benchmarks***

	IBM	COMPAQ	SUN	SUN		
MODEL	PC/AT 339	Deskpro 386/25	Model 3/50	386i Model 250[a]		
OPERATING SYSTEM	DOS	DOS	Unix	DOS (C:)	DOS (D:)	Unix
HARD-DISK SIZE (MB)	30	110	71	327	327	327
HLDISK (with disk cache)[b]						
Data file creation	1.59	2.91	0.60	1.04	1.42	0.32
Index file creation	34.72	13.68	37.30	30.00	114.67	12.80
First report generation	3.62	1.20	2.03	3.95	6.26	0.76
Data reorganization	5.05	3.46	2.69	5.21	7.58	1.20
Second report generation	1.20	0.65	0.49	1.26	1.70	0.27
Total	46.37	21.97	43.18	41.48	131.75	15.43

All times are in seconds, converted from 18.2-Hz timer ticks; therefore, total displayed is not always the exact sum of the individual results displayed.

[a] *Drive C: is a sector-compatible DOS drive simulated using a single Unix file; drive D: is mapped to the Unix file system. Unix test results were obtained using the HLDISK software compiled under Unix.*

[b] *For the IBM AT, a 256KB extended-memory disk cache was implemented using Multisoft's Super PC-Kwik disk cache; vendor-supplied caching software was used with the Compaq Deskpro 386/25 and the Sun workstations.*

When using the sector-level-compatible drive C:, the disk performance on the 386i is slower than on an IBM AT 339; using drive D: is slower still. The Unix version of the disk-performance test runs 50 percent faster than on the Deskpro 386/25.

The *Owner's Set* of four user's manuals neither insults nor humiliates. It contains a considerable amount of information and is, perhaps, the most useful means for the nonexpert to become acclimated to the reference manuals. The four manuals in the set are written in English rather than Unix-speak and are a help to a user interested in the problems of system administration and navigation.

The standard printed 386i documentation follows Unix tradition—it dwarfs what most DOS vendors consider complete system documentation. In fact, the manual set may be the most intimidating part of the system. The manuals, including the Software Development Toolkit, weigh a total of 64 pounds and take nearly four linear feet of shelf space. Fortunately, most are needed only for reference. Because of the advanced on-line help available, experienced users can set up the system and do useful work without touching a piece of paper.

Finding information is at least 50 percent of the battle. Those developers unfamiliar with Unix may have a long road to travel before becoming comfortable with documentation on this machine. The biggest problem with Unix documentation is simply finding a place to start. The reference manuals are not organized for cover-to-cover reading. They also seem to assume a certain minimum amount of broad-based Unix knowledge.

If disk space is available, it is highly recommended that the **_man_** pages cluster be installed. The Unix **_man_** command retrieves an on-line copy of the reference pages for a particular entry. It is much more convenient to use this on-line documentation, partially because typing **_man grep_** is a lot easier than physically finding the **_grep_** documentation.

Setting up the reference manuals is another issue. Sun does not provide binders for any manuals other than the four-volume *Owner's Set*. The *Software Development Toolkit,* for example, contains about 20 linear inches of unbound manuals. This will easily require a dozen three-ring binders or a manual rack. Developers would be well-advised to consider the cost of a set of rack-mount binders as an unlisted expense of the system.

INTRIGUING POTENTIAL

For those developers who are intrigued by the potential of the 386i, not surprisingly, Sun is willing to help you get started. Sun operates a program called Catalyst that encourages third-party software (and hardware) development targeted for Sun workstations.

Catalyst support ranges from catalog listing and sales referrals, through technical consulting and support, to seed programs that loan porting equipment. Catalyst's benefit to Sun is that it helps to build the support base of follow-on products that can make the difference between a successful product and a good-but-dead product.

Sun maintains porting labs on both the east and west coasts. Developers can set up appointments to use equipment during porting projects and can use whatever amount of time is necessary to get the job done. Before embarking on, or dropping, a porting or development project for a Sun workstation, a developer should check with the Catalyst program staff. They may be able to help.

For the developer, the Catalyst program is an added attraction to the already strong 386i Unix-DOS development environment. Like other Sun workstations, the 386i is an excellent environment for developing Unix applications. The system also is a hospitable platform for DOS applications development. Developers used to DOS systems should be able to configure their development tools with no problem.

The ability of the system simultaneously to run both DOS and Unix applications is its most exciting feature for developers. The 386i enables developers to connect and mix the tools from both environments in a way that is truly in keeping with the best spirit of Unix tool making.

Sun Microsystems Inc.
2550 Garcia Avenue
Mountain View, CA 94043
415/960-1300
Sun 386i Model 250 (prices for various configurations are given in the sidebar, "Sun 386i Vital Statistics," on p. 98)
CIRCLE 348 ON READER SERVICE CARD

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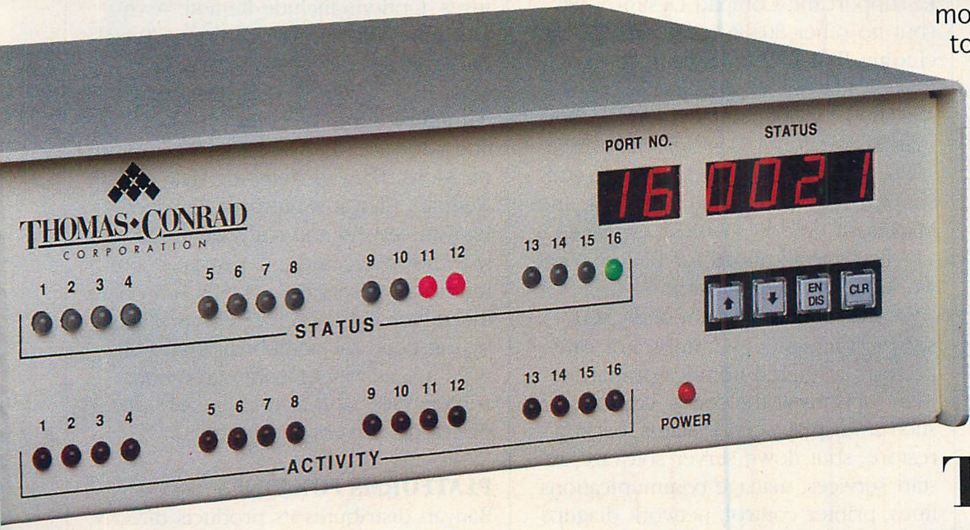

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Branching out with Banyan VINES

At the heart of the Banyan philosophy is the concept of *virtual networking*—the ability for users to communicate transparently locally and remotely, across similar and dissimilar networks, through a simple and consistent user interface. From the company's beginnings in 1983, its design for networks stressed a high degree of connectivity for large installations with multiple servers and extensive communications requirements. The networking market seems just now to be catching up to this vision.

VINES, Banyan's proprietary virtual networking system, sets the stage for virtual networking across Banyan servers and other vendors' hardware. It comes with a core of services that network administrators can customize by adding other products. The base price of VINES includes local area network (LAN) software for one network type (ARCnet, Ethernet, Token-Ring, Starlan, and so on)—software for file sharing, printer sharing, the StreetTalk naming system, tape backup and recovery, network time and date, and system administration services.

VINES is based on AT&T's Unix System V. Establishing network software on a mature, multiuser, multitasking operating system frees Banyan to focus on developing services for users rather than on nitty-gritty operating system issues. Banyan's developers have been able to add to the Banyan environment within the rules and standards of Unix, although the Unix connection matters little to end users because VINES offers no direct access to Unix.

Banyan also sells VINES/286 for AT-class machines and, in April 1988, released version 3.0 of VINES and VINES/386 to support the Compaq Deskpro 386 (but no other 80386-based system, including IBM PS/2s). Its Unix base makes VINES/386 3.0 the first 32-bit, 386-specific LAN operating system on the market. Version 3.01, released in June 1988, includes patches, bug fixes, and support for 3Com, Micro Channel, and Macintosh boards. (Table 1 on page 117 lists specifications for Banyan's network servers and software.)

VINES runs only on a dedicated server. The system administrator can perform a limited number of management options at the server console, such as display service status, backup/restore, shut down server software, restart services, manage communications lines, printer control, network diagnostics, and system maintenance. The administrator also can run most of these options from a PC on the network.

All VINES services (naming, file, printer, gateway, mail, and so on) execute as Unix processes; Banyan uses the term *service* synonymously with a Unix *process*. Each process has a built-in tasking system to facilitate multi-PC response within a service. Services can be stopped and restarted from the server console without interrupting other services.

End-user oriented, extra-cost components to VINES all have a standard menu interface and configuration features. Options include Remote Asynchronous Dial-in, Asynchronous Terminal Emulation (Dial-out), IBM 3270/SNA, IBM 3270/BSC (bisynchronous communications), Server-to-server LAN and wide-area network (WAN) communications, Banyan Network Mail, and Netman, Banyan's network manager. Banyan servers and software are expensive; however, because Banyan's communications services actually run on the server itself, no cost is introduced by the need for additional PCs to be used as gateway or communications servers (see table 2 on page 118, for prices on servers and options).

PLATFORMS FOR VINES

Banyan distributes its products directly, through value-added resellers (VARs), and through original equipment manufacturers (OEMs). Banyan's OEMs include: Convergent Technologies (Unisys), Lee Data, Northern Telecom, Proteon, Tallgrass Technologies, TRW, and Wang. The firm stands poised to

Poised for the market's expanding local and wide area networking needs, Banyan's VINES delivers sophisticated Unix-based operating software with distinctive, integrated communications options.

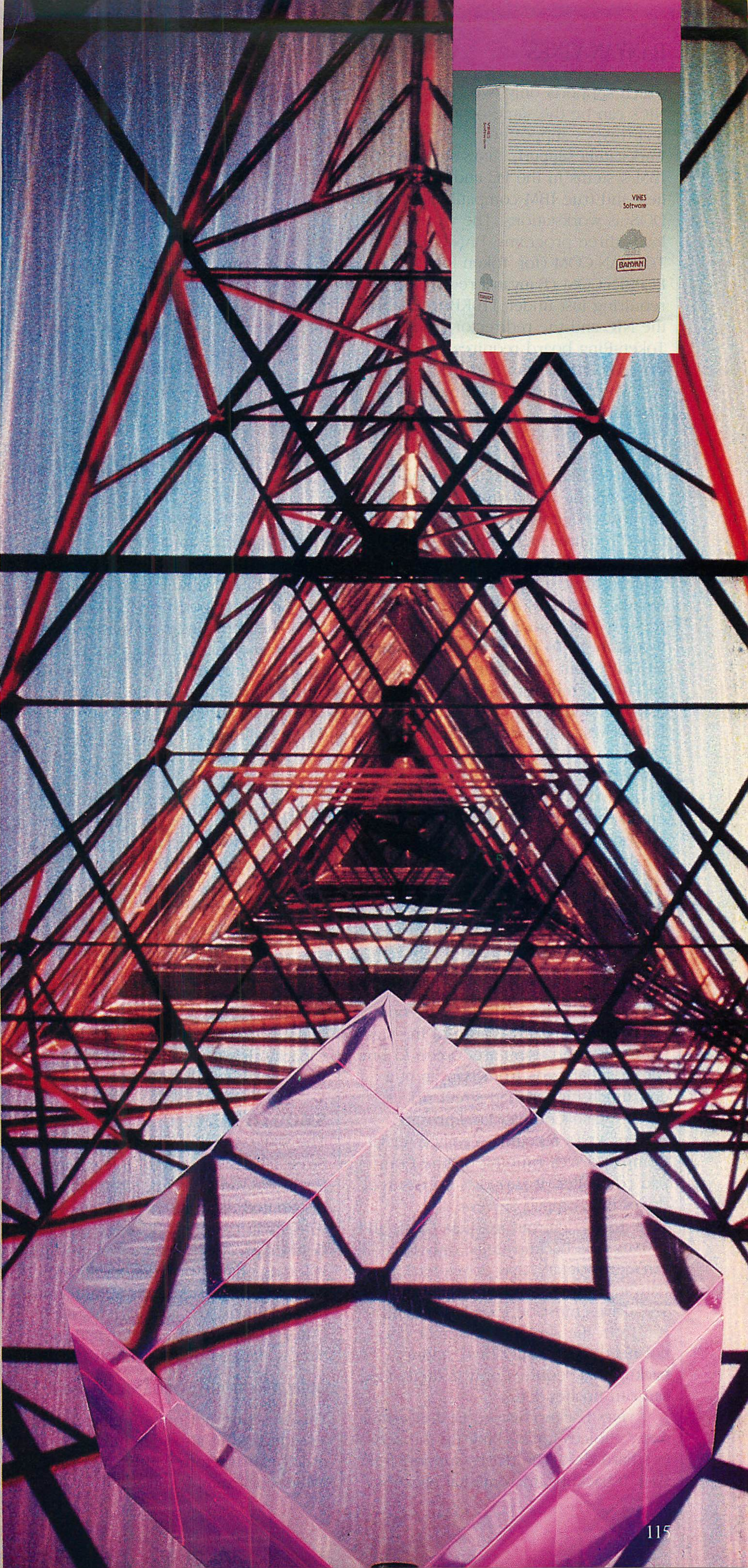
BRICE BONWILL

capitalize on its strengths in a market that sees the need for its communications and large-system capabilities.

Banyan manufactures and sells three proprietary servers that are optimized for network file-server functions. VINES is included in the price for each. The Banyan Network Server (BNS), which sells for $17,245 to $19,995, and the Desk Top Server (DTS), at $8,995 to $12,995, are based on the Motorola 68000 running at 10 MHz with a bus speed of 4.7 MHz (see table 2). The Corporate Network Server (CNS), an 80386-based platform, is Banyan's high-end server, listing at a breathtaking $31,995 for a model with 320MB disk storage and 8MB of RAM.

The company also markets a hardware upgrade kit to convert a 68000-based BNS into a 386-based CNS. Banyan can outfit its servers with an integrated uninterruptible power supply for $725 and either a 60MB or 150MB tape drive, for $1,895 or $2,495, respectively. The servers have three separate buses for memory, disk I/O, and external I/O, which improves performance by eliminating bottlenecks (figure 1 on page 119 shows the bus architecture).

All servers running VINES are interoperable and work together on one LAN. Banyan supports a maximum of four network interface cards (NICs) in one server, except the 80286 version,



PHOTOGRAPHY • JOHN LEI   STOCK IMAGE • STEVE GOTTLIEB

which supports only two NICs. The NICs can be the same or a mix of the board types supported.

Workstation support. VINES supports all IBM systems in the PC and PS/2 families, and true IBM compatibles, running DOS as workstations. The workstation loads three programs: BAN.COM, TOKBAN.COM (for Token-Ring), and ECPBFS.COM (Banyan's redirector), requiring just under 110KB to enable the NIC and the redirector. The IBM Token-Ring board requires no device drivers on a Banyan network.

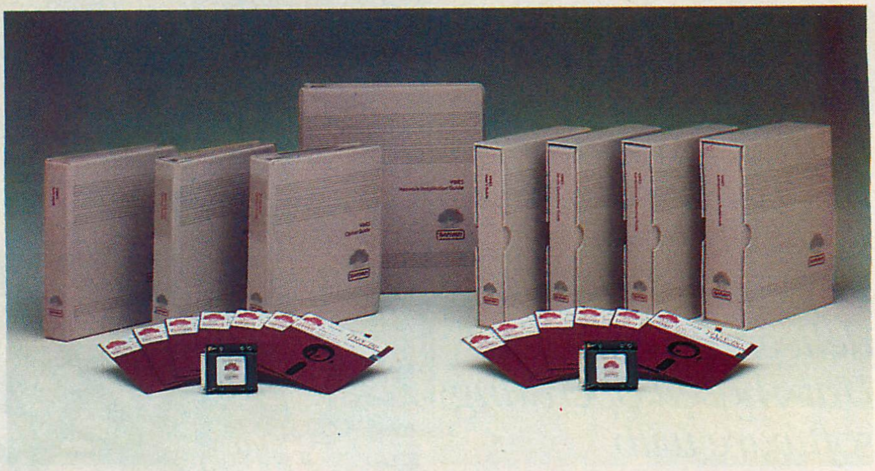
The memory consumption is high compared with Novell (which is about 60KB, depending on the NIC, for driver and redirector), but is offset by the low overhead Banyan's 3270 gateway imposes on the workstation. The 3270 support program with the hot key enabled requires an additional 67KB of RAM; without the hot key, the program requires only 40KB. Gateways available for MS-Net and Novell networks usually require 150KB to 200KB of RAM on the workstation. To run programs requiring NETBIOS calls, the user must load a NETBIOS emulator at the workstation, using an additional 30KB of RAM.

Disk drives. Increasing numbers of LANs are moving to storage capacities of more than 1GB. Banyan servers support a maximum 2.5GB of disk storage on a server, but achieving that capacity is costly because of Banyan's policies on disk drives. Banyan proprietary servers require that Banyan supply replacement and additional drives. The company tests and initializes every disk. If the disk does not have a Banyan electronic signature on the media, VINES refuses to work with it. Banyan uses drives from Fujitsu, Maxtor, Micropolis, and Quantum, but because of the signature, Banyan users are forced to buy replacement parts from Banyan at a cost much higher than street prices.

Even in Compaq Deskpro 386 servers, VINES recognizes only internal Compaq drives running on the Compaq controller. It supports no external drives on Compaq servers.

Tape drives. Banyan markets 60MB and 150MB tape backup units; only Banyan's proprietary tape drives back up Banyan servers in a Unix file format. The drives must be installed on and run from the server. The server does not need to be shut down, and a backup that requires only a single tape can run unattended.

VINES backup/restore facilities offer many choices for backing up the server's hard disk. The drives support full system backups, incremental backups, or selective backups by file or service. Administrators can automate backup initiation based on day of the week and time of day, enabling them to back up in low-activity periods.



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Banyan's documentation is extensive, but well-organized. A technically minded VINES novice should have no problem installing VINES/386 right out of the box.

The operating-system scheduler assigns the backup task a low priority; thus, the time required for a backup varies. On a lightly loaded server, the operation can fill a 150MB tape in less than 30 minutes. The limited tape drive size and the requirement of running on the server can be an administrative nuisance for large multiserver LANs, whose servers have large disk capacities. Not only must backups be run on each server instead of from some central location, but tape swapping can be time-consuming.

Banyan tape drives are acceptable for systems with a hard disk smaller than 500MB, but for larger systems, Banyan does not offer a complete solution for backup. The company has no announced plans for increasing tape capacity or supporting other manufacturers' tape drives

SMOOTH TALKING

The VINES resource-naming service, StreetTalk, is a powerful integrating factor in Banyan software. StreetTalk is a distributed database for all named resources in the network. Resources can be users; services, such as shared file volumes, shared printers, and host gateways; or lists, such as administrator list (AdminList) or access rights list (ARL). The name structure has three tiers, separated by @ symbols:

OBJECT@GROUP@ORGANIZATION

This structure not only uniquely names a resource, but also identifies an organizational structure within the resource name. For example, StreetTalk would list John Doe in sales at XYZ company as JOHN DOE@SALES@XYZ (blanks are acceptable in names).

StreetTalk supports nicknames, such as JohnD for the above example, thereby eliminating the need to enter long names; the software resolves the relationship automatically. StreetTalk also accepts the wild-card indicator * at any level: *@*@XYZ matches any name within XYZ organization.

StreetTalk's power stems from VINES' ability to dynamically and globally exchange StreetTalk database information among servers in the network, whether servers are located locally over LAN cable or remotely over WAN links, such as high-level data link control (HDLC), X.25, or Banyan's Async. Each server on a Banyan network automatically maintains a StreetTalk table with the names and locations of every group known to the network. When a process requests connection to, or information about, any object on the network, the local server uses that network address to resolve the request. A user logging on to the network at any location is recognized and admitted based on information entered once on his home file server.

Multiple servers exchange StreetTalk information at group level via automatic server-to-server communications called *outbound blasts*. Outbound blasts occur whenever a new server joins the network, when the administrator adds or deletes group or service information, and every 12 hours from the time the last server came on line.

In contrast, 3Com Corporation's single logon results from a naming service running on a single server, which then controls all network access. This strategy requires that the administrator define all users on the name server,

TABLE 1: *Banyan Proprietary Servers and Network Options*

	BNS	CNS	DTS	VINES/286	VINES/386
Recommended users	15 to 60	20 to 100	5 to 25	2 to 12	5 to 40
CPU	68000	80386	68000	80286	80386
Clock speed	10 MHz	20 MHz	10 MHz	6, 8, and 10 MHz	16, 20, and 25 MHz
RAM	2 to 8MB	4 to 24MB	2 to 5MB	2 to 16MB	4 to 16MB
Maximum LAN boards	4	4	4	2	4
Serial communication ports	30	30	12	4	12
Printers supported	6	10	6	5	6
Maximum disk storage	1.8GB	2.5GB	664MB	314MB[b]	600MB[a]
Battery backup	Internal	Internal	External	External	External

[a] *VINES/396 supports a maximum of two ESDI or two ST-506 drives.*
[b] *VINES/286 supports a maximum of two ST-506 drives.*

Banyan's proprietary servers—the CNS, BNS, and DTS—all come with VINES; Banyan also sells VINES/386 and VINES/286 software for other hardware platforms. The CNS, which was introduced in April 1988, is Banyan's top-of-the-line server.

which then is critical to access all servers on the LAN, but is difficult to support over WAN links.

Novell administrators define each user on each server to which the user is granted services. Novell's naming scheme can entail substantial administrative overhead on a very large internetwork. The Novell MAKEUSER utility simplifies the process by allowing for batch additions and deletions of users, but still entails managing resource access on a server-by-server basis.

Resource sharing on a VINES network is logical and simple to administer. As a network gains users, services, resources, and servers, users and administrators see more resources listed on the menus. To end users, a Banyan network appears as a single system; file servers are not separate entities, but unseen pieces of the whole.

TIGHT SECURITY

VINES security is tightly integrated with StreetTalk. Every network resource, service, and communications link has an ARL that specifies the users authorized to access the resource.

VINES establishes network security when AdminLists are created. AdminLists are StreetTalk lists that contain individual names or lists of names of users who can modify the StreetTalk catalog and manage specific parts of the VINES network. End users can exclude even the system administrator from looking at their files—an attractive feature for security-conscious sites.

Security is enforced at several points in VINES, including server console operation, server-to-server internetwork data exchange, service access, and user network login. Server console operation includes passwords required for some potentially destructive or invasive options, such as field-service diagnostic routines.

Three classes of access are available: *unrestricted* access permits two networks to exchange all information and appear to be one network; *restricted* access allows two networks to exchange only Network Mail, not StreetTalk names; and *secure* access permits no exchange of information. It is provided for sites that want to share the same physical media, but have no internetwork communications between some Banyan servers.

ARLs define the security for file access at the directory level (root and subdirectory), but not at the file level. VINES has four access levels for files: *control* access allows complete control of a directory, including create, modify, read, delete files and subdirectories, control access rights, and delete directory; *modify* access allows create, modify, read, and delete; *read* access allows read and copy rights; and *null* access explicitly excludes a user from all rights to a directory. Subdirectories with no ARLs specified automatically use ARLs of their parent directory. VINES also supports setting file sharing/executing attributes at the file level.

Service access has multiple levels of security, depending on the service type. For example, file services implement the ARL, which identifies who can access files and at what level users can access file information at the directory level. Other services permit restricting use to a specific user, group, or organization, based on StreetTalk name. The Systems Network Architecture (SNA) gateway service can restrict use all the way down to the logical unit (LU) level, also based on StreetTalk name.

With version 3.0, Banyan has improved on the password-only level of security with the introduction of VANGuard, a new standard service. VANGuard offers features that prevent unauthorized system entry, including password encryption, unauthorized login tracking, restricted internetwork initiation, and no session reply (which prevents unauthorized access to network traffic). In addition, VANGuard offers password modification and expiration, limiting users to certain logon times or certain physical locations, and control of dial-in access.

DIAGNOSING VINES

VINES includes diagnostic facilities for all supported hardware and software components. These include a logging facility that automatically records information such as logins, logouts, and errors for each service, plus a general system log.

Banyan's hardware diagnostic facilities cover all server components. A VINES server monitors for hardware and software errors and attempts to recover automatically. If, for example, a LAN board in the server does not respond to a check, after a period of time the system automatically resets and reinitializes the LAN board. In some failures, the system reboots the server. This happens if the system detects a memory parity error: the system records the problem and reboots the server. Banyan provides diagnostic utilities for each supported LAN interface board at the workstation level.

Netman, an optional Banyan product (described below), performs real-time monitoring of network resources and load; it is licensed by server. Netman monitors and accumulates error

counts for all network interfaces (LAN NICs and WAN communications boards) in the server. An administrator can evaluate activity and problems on the LAN by reviewing this information.

HELPING THE ADMINISTRATOR

StreetTalk's propagation of user rights across an entire network greatly facilitates administration of a large multiserver configuration. The system identifies administrators by including their StreetTalk name in an AdminList. VINES creates two such lists. Users on a server AdminList are authorized to add and delete services on a server, as well as to add new servers and organizations to the network. Users on a group AdminList manage all of the resources in that group, including users, lists, nicknames, and services; they also can create new groups.

The NEWREV utility handles upgrades to Banyan workstation software. VINES detects old versions on the workstation and invokes NEWREV at logon; this automates the download of new versions of VINES workstation software to the PC after installing changes to VINES on the server.

VINES has shortcuts for management functions. For example, *profiles* are logon scripts containing a series of VINES and DOS commands that the administrator can save to a file, recall, and modify. Banyan profiles are similar to Novell scripts or DOS batch files. The system maintains a profile for each user and executes it when the user logs on to the network. All services are mapped or linked within a profile.

VINES file services manage DOS file storage on server disks; in explaining the services, Banyan uses the terms *network drive*, *file service*, and *file volume* interchangeably. A *file service* is equivalent to one volume whose size is limited only to the physical capacity of a single disk. One disk can be defined as several volumes, each of which must be defined as a separate VINES file service. A file cannot exceed the size of a single physical disk. A file service as viewed from a client's PC is the normal DOS disk structure (that is, root directory with subdirectory file structure).

The SETDRIVE command maps a PC to a file service. Drives can be mapped through the user profile or by entering SETDRIVE at the DOS prompt on the workstation. Search drives are equivalent to DOS path search capability for executable files only.

VINES supports the open systems interconnection (OSI) standard with both its own protocols and industry-standard protocols (figure 2 diagrams the relationship between VINES and the OSI model). VINES also supports DOS 2.0 to 3.3 file-system calls.

VINES print services facilitate the sharing of printers. Like all VINES resources, each print service has an assigned StreetTalk name. A print task executes in the background on the local PC and a print service is defined at the server. With version 3.0, a PC on the network can have its locally attached printer function as a network printer, in addition to the printers attached directly to the server.

Print jobs are spooled to the server's hard disk and despooled to a network printer. Options include printing banner pages with each job, despooling jobs based on form type, and sending a standard character string before and after printing each job (to assure that the printer is reset to a normal state). Users have complete control over their jobs, and system administrators can manipulate entire queues. A user can have all three printers mapped as network printers or a combination of local and network printers.

ROOTING VINES

Server hardware setup and installation of VINES is a moderately advanced task and requires a technically able installer who is prepared to answer all the questions at software prompts. Yet, for a product as sophisticated as VINES, the process is remarkably easy.

VINES for Banyan hardware is distributed on a ¼-inch tape cartridge. VINES/286 and VINES/386 are distributed on diskettes. Installation documentation accompanies the hardware and software. Banyan controls the use of its products (Network Mail, Netman, Gateways, terminal emulations, and/or server-to-server WAN) through a tedious system of server and option keys.

The server key is a 25-pin hardware-protection device that connects to parallel port 1 on the server; it identifies the optional features purchased. VINES automatically validates and permits the use of optional features according to the key contents. The server key must be in place while the server is operating, which introduces a point of failure in the overall system. You can remove the key after power up, but the risk of its not being installed to reinitialize the server outweighs any advantage to taking it out.

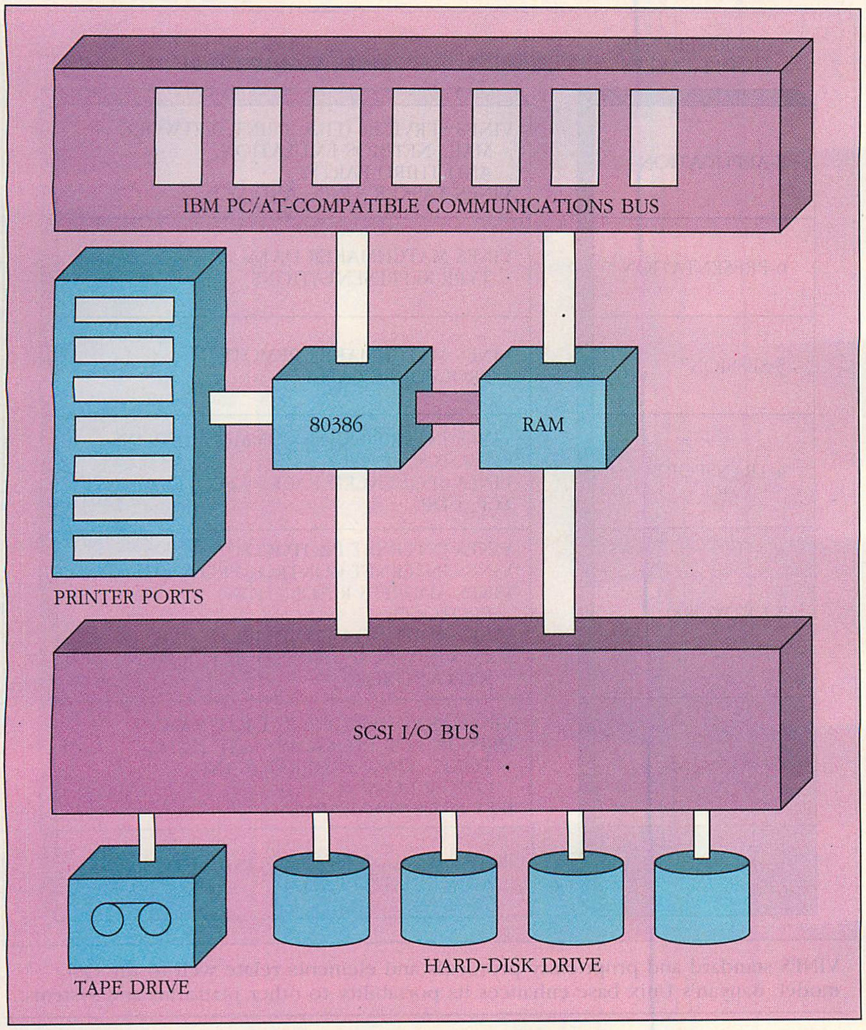
Banyan outlines detailed performance considerations that administrators should study when configuring services. Each service requires computer resources (memory and CPU cycles) to execute. VINES swaps services to the system disk when memory is short for executing services. If swapping reaches too high a level, the entire server's performance degrades.

TABLE 2: ***Banyan Pricing on Servers and Options***

	PRICE
SERVERS	
BNS (2 to 4MB of RAM; 80 to 146MB hard disks)	$17,245 to 19,995
CNS (4 to 8MB of RAM; 80 to 320MB hard disks)	23,795 to 31,995
DTS (2 to 3MB of RAM; 52 to 146MB hard disks)	8,995 to 12,595
VINES/286	1,895
VINES/386	4,995
OPTIONS	
2 to 8MB memory for Banyan servers	1,895 to 8,895
Persyst four-line communications board	850
Banyan ICA six-line communications board	1,500
Console required for BNS, CNS, and DTS	395
Uninterruptible Power Supply (included on BNS and CNS)	725
60 to 150MB tape for VINES/286 and /386	1,895 to 2,495
Asynchronous remote dial-in	1,495
Asynchronous terminal emulation	1,545
Mail	995
Netman	575
Network PC/print	495
Server-to-server LAN	1,000
Server-to-server WAN	1,595
Systems Network Architecture (16 to 96 sessions)	2,990 to 5,990

LAN administrators must weigh cost against consistency. All of Banyan's end-user oriented, extra-cost options have a standard menu interface and configuration.

FIGURE 1: *CNS Triple-bus Architecture*



Banyan's proprietary servers have a unique design, separating communications, memory, and storage I/O into three separate buses to enhance system throughput.

As options are added, the administrator can reconfigure their authorization on the server key. An option key comes with each option; the administrator transfers authorization from the option key to the server key by temporarily attaching the option key to the server key and selecting the appropriate transfer at the server console. Once you reconfigure the server, you can remove the option key and reattach a printer to the server key. This process requires an on-site operator to install such software-only options as Network Mail and Netman. Transferring options between servers can be cumbersome, requiring location of the correct option key, deinstalling the option, and then reinstalling it on the second server.

Apart from the potential problems introduced by option keys, installing VINES is a model of simplicity—easier on Banyan proprietary servers than on a Deskpro 386, due to the interrupt, direct-memory access (DMA), and I/O port limitations of all AT-bus PCs. After installing all desired ports and network boards and noting the settings for each, the installer boots the intended server using the VINES Install/Utility diskette. The software then leads you through instructions for reformatting the disk for Unix, installing the other 12 diskettes, and configuring the server to recognize the ports and LAN boards.

The system requests a unique server name, the first organization and group name, and the name of the user who is classified as the server system administrator. The administrator selects and monitors servers by server name; server names cannot change later without a reinstallation. After loading the software and defining the hardware, the installer reboots the server, which automatically proceeds to the final phase of installation—the definition of groups, users, and services.

LINES OF COMMUNICATION

When *PC Tech Journal* editors asked Banyan customers why they chose VINES, the answer almost always was "communications." According to Banyan, many of its users see Banyan's SNA gateway as a solid communications link between the LAN and an SNA host. Banyan provides its server-based communications facilities on three add-on boards available through the company.

The Intelligent Communications Adapter (ICA), introduced in April 1988, is the primary communications product. It supports SNA, HDLC, Async, X.25, and TCP/IP. The ICA board works with either 8- or 16-bit slots; it has an on-board 286 and 512KB of RAM supporting six lines (ports).

Each port supports all protocols and asynchronous speeds up to 19.2 kilobits per second (Kbps); however, ports 1 and 2 take advantage of the board's DMA controller in synchronous mode, and only these ports can support synchronous line speeds of up to 64 Kbps. Using a DMA controller reduces the load on the board by passing a block of information to the 286, relieving it from processing each character. Thus, it is important to assign synchronous services to ports 1 and 2.

All server models except VINES/286 support multiple ICA boards; VINES/286 supports only one board. Each board supports multiple protocols simultaneously on different lines. Banyan gives explicit instructions for determining the communications load on each board; the company rates the ICA board as having a total aggregate throughput of 144.8 Kbps. To determine total demand on each board, the calculation is:

(Line *n* Load = Load Factor * Line Speed)

and

(Total Load = Line1 Load + Line2 Load + . . . + Line6 Load)

For example, an SNA service has a load factor of .04 on ports 1 and 2 of an ICA board. A 64-Kbps link on line 1 or 2 yields a line load of (64 * .04) or 2.56 Kbps. On ports 3 through 6, an SNA service has a load factor of 1.2 and an upper limit of 19.2 Kbps, which yields a line load of 23.04 Kbps. Asynchronous services have load factors of 2.3 for block and 2.4 for character protocol, regardless of port. VINES' scheduler sets priorities for lines on a board in descending order with line 1 being the highest priority.

A second communications board, the Persyst DCP-88/VM, is the ICA's predecessor. It differs from the ICA in

that it supports bisynchronous communications, does not support X.25, has a maximum transmission speed of 19.2 Kbps for synchronous and 9.6 Kbps for asynchronous communications, and is limited to a total aggregate throughput of only 38.4 Kbps. The third board, from Eicon Technology Corporation, is used solely for X.25 communications at speeds up to 56 Kbps.

WIDE OPEN

Banyan's WAN communications offerings fall into three categories: server-to-server, host mainframe or minicomputer gateway and terminal emulation, and remote PC dial-in. The administrator must configure all communications facilities at the server's console.

Banyan supports multiple protocols for WAN server-to-server communications. Each method has associated incremental costs. Async is the least expensive, HDLC next, then X.25, but all offer a consistent interface for communications between servers.

Of course, implementing a WAN over any medium communicating in the thousands-of-bits-per-second range does not provide the same end-user response times as LAN connections. VINES supports the scheduling of unattended calls to remote servers on the basis of time of day and day of week; thus, sites can take advantage of off-peak, long-distance rates.

VINES supports terminal emulation for most mainframe and minicomputer environments through either its Async, IBM 3270/BSC, or IBM 3270/SNA terminal emulation options. Once services are defined and started, end users access them completely through menus.

Asynchronous terminal emulation support includes VT-100, VT-52, IBM 3101, and teletype (TTY) emulation. Banyan licenses this option per server, with the largest CNS server supporting a maximum of five ICA boards, providing a maximum of 30 asynchronous lines for both Async and Remote PC Dial-in (see table 1 for maximum services per server). Banyan's Async service supports only the Kermit file-transfer protocol. The lack of XMODEM and other file-transfer protocols is a serious deficiency. Third-party software from vendors such as Trellis Software support a broader range of protocols on Banyan networks.

Banyan licenses the IBM 3270/SNA option per server, which provides for any PC on the network to start a terminal and/or printer session with any IBM mainframe supporting remote 3270 SNA communications. This emulation feature is available in 16-, 32-, 64-, and 96-session increments.

The 3270/SNA gateway emulates a 3274/76 communications controller that connects via leased or dial-up synchronous facilities to an IBM front-end communications processor (3705/20/25/45) at speeds of up to 56 Kbps. Each gateway service supports a maximum 32 sessions and uses one port on the ICA board.

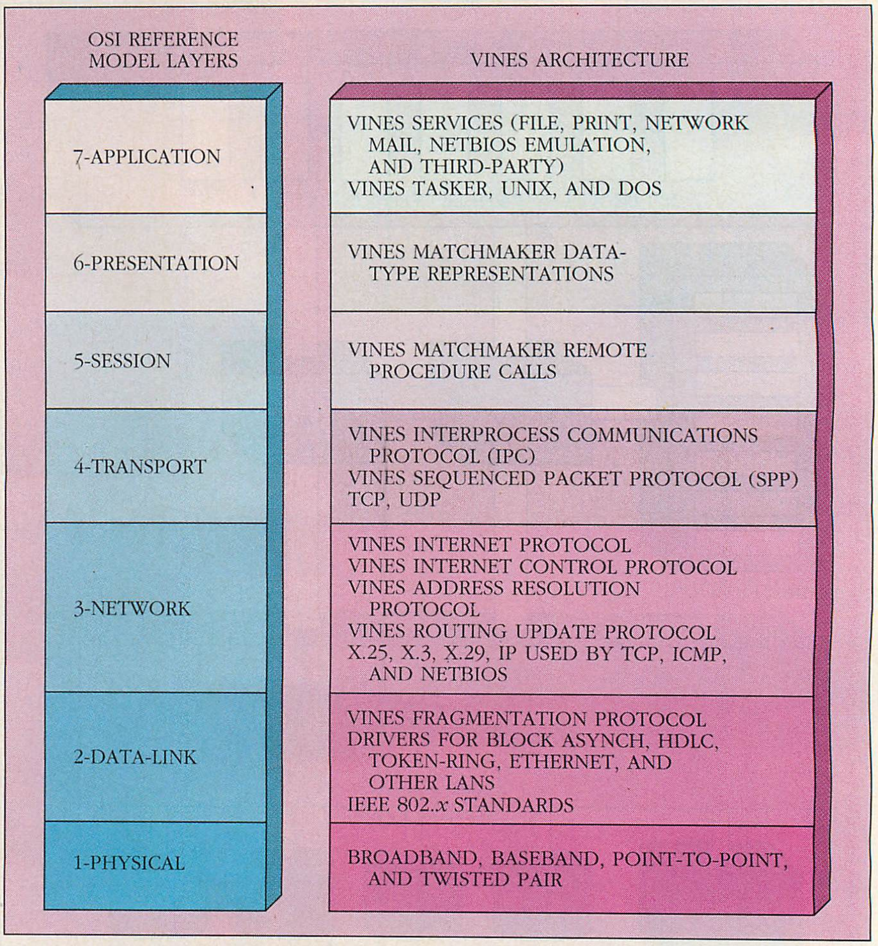
Interviewed users of Banyan's SNA and asynchronous services uniformly agree that the services are extremely reliable. According to users, the SNA service compares favorably with terminals and coaxially attached PCs with 3270 boards running at the same communications speeds.

Banyan supports file upload/download under two different methods. One uses a time-sharing option (TSO) edit and list facilities; the other requires that IBM's IND$FILE 3270-PC File Transfer Program be installed on the mainframe. The gateway has the capacity for a user to have as many as four simultaneous terminal sessions active, capture print data to a file, or print directly to a local printer or a network printer. Banyan does not support 3270 emulation via direct token-ring connections, nor does it support channel speed connection. These options would eliminate the need for front-end processors (37x5) to have 3270 terminal emulation over the LAN.

Banyan's bisynchronous communications facilities support IBM BSC/3270 mainframe connections in 32- or 64-session packages. The emulation is similar to SNA/3270 functionality in that it provides 3270 terminal emulations over bisynchronous communications facilities. The maximum transmission speed using this protocol is 9.6 Kbps. (However, CNS does not support the PERSYST board, so BSC cannot be supported on that server.) HDLC is supported for integration over leased-line facilities at speeds up to 19.2 Kbps.

TCP/IP is a newly (April 1988) supported protocol for server-to-server integration over TCP/IP backbones. VINES

FIGURE 2: ***The OSI Model and Relative VINES Components***



VINES standard and proprietary protocols and elements relate well to the OSI model. Banyan's Unix base enhances its portability to other platforms and systems.

Two new DESQviews.

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DESQview™ is the operating environment that brings OS/2™ power to DOS. And it lets you, with your trusty 8088, 8086, 80286, or 80386 PC, leap into the next generation in PC productivity. For not much money. And without throwing away your favorite software.

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While other programs get bigger, we've worked to make DESQview smaller. And we've succeeded in a big way on PCs and PS/2™s with extended, EMS 3.2 (AboveBoard), EEMS and EMS 4.0 memory—as well as on 386 PCs and PS/2s. For example, DESQview overhead on EMS 4.0 and 386 PCs can be as low as 10K on EGA/VGA PCs. And

DESQview actually *increases* memory 30K on CGA PCs; 20K on monochrome and Hercules PCs. That's good news for users of big desktop publishing, CAD and database programs.

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For users of 80386 PCs and PS/2s (or PCs with 80386 add-in boards, such as the Intel Inboard 386), there's DESQview 386 (a combination of DESQview 2.2 and the new QEMM-386 Quarterdeck Expanded Memory Manager, version 4.2).

> For programmers, DESQview's API, with its strengths in inter-task communications and multitasking, brings a quick and easy way to adapt to the future. With the API's mailboxes and shared programs, programmers are able to design programs running on DOS with capabilities like those of OS/2.

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DESQview System Requirements: IBM Personal Computer and 100% compatibles (with 8086, 8088, 80286, or 80386 processors) with monochrome or color display; IBM Personal System/2• Memory: 640K recommended; for DESQview itself 0-145K• Expanded Memory (Optional): expanded memory boards compatible with the Intel AboveBoard; enhanced expanded memory boards compatible with the AST RAMpage; EMS 4.0 expanded memory boards•Disk: two diskette drives or one diskette drive and a hard disk•Graphics Card (Optional): Hercules, IBM Color/Graphics (CGA). IBM Enhanced Graphics (EGA), IBM Personal System/2 Advanced Graphics (VGA)• Mouse (Optional): Mouse Systems, Microsoft and compatibles• Modem for Auto-Dialer (Optional): Hayes or compatible• Operating System: PC-DOS 2.0-4.0; MS-DOS 2.0-3.3• Software: Most PC-DOS and MS-DOS application programs; programs specific to Microsoft Windows 1.03-2.1, GEM 1.1-3.0, IBM TopView 1.1• Media: DESQview 2.0 is available on either 5-1/4" or 3-1/2" floppy diskette.

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CIRCLE NO. 152 ON READER SERVICE CARD

supports TCP/IP as a router for both VINES packets and non-VINES packets so that a host system can route message traffic via the TCP/IP routing feature of VINES. Banyan also produces a software package, called TCP/PC, that allows a PC to execute both VINES workstation software and TCP/IP terminal software simultaneously.

Remote PC dial-in enables a user to dial in to the network from a PC and work as a locally attached node over an asynchronous line. The slow operation of asynchronous communications makes this option useful only for limited transmission applications and thus requires planning. This is a useful service for remote sites with one or two PCs that need to access the mail system or take advantage of some other service, such as an SNA connection.

MAIL CALL

Banyan licenses its server-based, full-function electronic mail (E-mail) option, Network Mail, on a per-server basis. Network Mail uses StreetTalk's naming service for addressing and distributing mail messages, and VINES network routing facilities for transporting mail. The package is menu driven.

Within each mail service are mailboxes; within each mailbox are folders; and within each folder are mail messages. VINES automatically creates two folders, GENERAL and WASTEBASKET, in each user's mailbox upon assignment to a mail service. Users create additional folders as needed.

GENERAL is the default folder in which mail messages are saved. When a user deletes a message, it is not destroyed immediately, but moved to the WASTEBASKET folder. Users can retrieve and move messages from WASTEBASKET back to one of the original folders. WASTEBASKET folders are emptied automatically every day at 3:00 a.m. through a process called JANITOR that VINES schedules. Once JANITOR runs, all deleted messages are gone.

A system administrator can move a user's mailbox to another mail service or delete an entire mailbox, but only the original user can manipulate the contents of the mailbox. The system administrator can, however, restrict the total number of messages users accumulate. Users must delete extra messages to create or receive new mail. Banyan Mail supports carbon copies, blind carbon copies, certified mail, and an address book facility that lets end users create mailing lists. Banyan offers a mail gateway toolkit as part of the applications programming interface (API) tools (see the sidebar "Banyan APIs Arrive" on page 123).

VINES handles mail routing transparently to users. Mail routing between servers in a VINES network depends on how the servers are connected. For servers connected via permanent links, LAN cable, or WAN direct connection, mail exchanges continuously. For temporary dial-up links, VINES transfers mail automatically when the link is active. Banyan also offers a facility to indicate forced routing to intermediate servers when mail has to traverse two or more transitory links as would be the case if servers were using periodic dial-up links for mail transfers.

Although Banyan's Netman is an optional network monitoring tool for VINES, its troubleshooting services are essential to any LAN.

Consider a network with three servers, A, B, and C, that are physically located in California, Texas; and Virginia; all servers have server-to-server (WAN) options installed using temporary dial-up connections between servers. Server B communicates with both A and C but at different times during the day, and server A never has a physical link with C or vice versa. In this case, users on either A or C would have to specify forced routing for the respective users on the opposite servers. Mail destined for users on C from A and to A from C would be routed to B in a store-and-forward manner and delivered to the end user when either A or C temporarily links with B.

NETMAN TO THE RESCUE

Netman is an optional network monitoring software tool for VINES. Licensed per server, it reports on the overall activity of individual servers, services, and connections (such as server NICs). Netman provides extensive information gathering and display, but does not record statistics to a log file because the files would be too large to be useful. Without a data-recording capability, it is extremely difficult to do trend and performance analysis and capacity planning based on day and time-of-day activities. Nevertheless, Netman is a valuable tool for troubleshooting, performance monitoring, and capacity planning. It is essential for any network.

Netman is menu-driven and is invoked from either the operator console or any PC on the network. The first menu displays all servers on the network that can be marked for study. Netman displays all marked servers in a VINES Network Summary Menu with one line per server. Each entry shows server name, server load averages, message average per second, total messages in and out since Netman became active, message drops, and swapping average (average swaps from memory to disk per second over one minute).

Netman's menu offers three basic options. The first is Display I/O Statistics, which shows performance counters for VINES IP (internet protocol) and IP traffic, and for all of the server's network interfaces (LAN and WAN). This menu also provides access to menus that display disk usage statistics or details about any network interface, such as total number of messages in and out over the interfaces, as well as errors and more specific interface data.

The second option is Display Service Statistics, which enables selection of a server and displays statistics about services running on the server. This option provides data on the activity levels of services, which assists the administrator in improving performance.

The third option is Display Neighbors, which shows the configuration of active nodes in the network connected to the server selected. The information displayed is for each network interface (LAN and WAN) into the server; also displayed are the nodes attached to each interface. The nodes have accompanying information, such as LAN ID, network ID, and StreetTalk name of the user logged in via the interface. This display facilitates viewing active server network interfaces as well as current users of those interfaces.

A JUDGMENT CALL

Evaluating LAN server performance is difficult because of the myriad variables (see "The LAN Performance Challenge," Steven S. King, June 1988, p. 46). Speed of file reads and writes is but a single dimension of performance to consider in a large, complex LAN that offers many services and supports many users who are performing a wide variety of related and unrelated tasks all at the same time.

In addition to file I/O, some issues to assess regarding a LAN server's performance are the work environment, the functions supported by the LAN,

loads created by services, acceptable ranges of performance for all services, internetwork performance, and performance under load. In environments of even 30 or 40 DOS workstations on a server, LAN servers are subject to low demand levels most of the time. Spreadsheets, word processors, E-mail, and related printing are still the primary PC applications running LANs. Loading executable files and documents, printing, and transferring large files are usually the largest sources of network load, but are of short duration.

Communications services do not place large loads on servers because of coprocessors and the slow speeds available for external communications. Occasionally, LAN servers must handle very heavy loads for short periods when many users' requests coincide. The speed and performance of the network topology must be accounted for and held constant.

Even taking this perspective, two important areas give indication of a LAN server's performance: acceptable speed of response under light loads and graceful degradation under extreme loads. Acceptable speed is the speed of a hard disk on an AT-class system. Graceful degradation implies that a system under load may slow down or generate recoverable error messages, but not crash in a way that jeopardizes data integrity or the operation of other file servers or workstations.

Using the simple yardstick of acceptable speed and graceful degradation, Banyan performs well, indeed. *PC Tech Journal*'s network performance utility, LANPERF, which measures the throughput in kilobytes per second (KB/s) of applications making DOS calls, was applied to VINES on an IBM Token-Ring Network, with a 16-MHz Compaq 386 server with 6MB of RAM and 8-MHz IBM PC/AT workstations. VINES ran LANPERF tests with throughput generally twice that of an uncached AT's hard disk. As block size is increased, Banyan's performance rises to as much as twice that of the tested AT's hard disk. A series of read tests in using 64 blocks of increasing block sizes (1 to 4,096 bytes) yields the following results for sequential reads:

BLOCK SIZE (bytes)	THROUGHPUT (KB/s) AT	NOVELL	BANYAN
1	2	3	3
10	18	39	32
64	27	50	72
256	25	59	135
512	29	63	99
1,024	50	96	105
2,048	76	96	118
4,096	102	97	159

Clearly, Banyan leads in throughput for a single station, but a user without a stopwatch might be hard-pressed to see the difference. In rerunning the read test using only one block at each block size, the numbers became staggering. Banyan's buffering of 1K blocks at the workstation yields throughput numbers at the level of a RAM disk for large block sizes. Novell's high performance at 256-byte blocks reflects DOS buffering. Using a single block is an upper limit test that might reflect

BANYAN APIs ARRIVE

Banyan anticipates the release of a VINES Application Toolkit in the first half of this year. The toolkit will provide APIs and instructions for developers to create distributed applications based on a VINES server integrated with the VINES networking software. It may be difficult to get enthusiastic about another proprietary LAN API, but Banyan's Unix soul may be its salvation.

Essentially, the toolkit will open up the underlying Unix System V to developers. It will provide access to a Unix login shell on the server, a subset of standard Unix System V commands, and a DOS-Unix bridge file service that allows access to development files from either operating system. Standard Unix System V commands supported include utilities for creating and compiling source code, the vi text editor, and several Unix utilities. Banyan refers developers to the *Unix System User's Manual for System V* for information on supported standard commands.

The toolkit package will include software, documentation, and an option key to authorize installation of the toolkit on the server. The documentaion consists of six separate sections covering the architecture definition, application developer's guide, application developer's reference, mail gateway programming interface, TCP/UDP programming interface, and X.25 programming interface.

The *VINES Architecture Definition* gives an overview of VINES, the relationship of its components to the OSI model, and descriptions of VINES interprocess communications and Banyan applications. It provides a good overview of VINES structure and how it relates to users and developers.

The *VINES Application Developer's Guide* provides detailed background on the development process, using StreetTalk, VINES' remote-procedure call generator (Matchmaker), the VINES tasking system, communications calls, integration of a service with VINES, releasing services into distribution, and an example of developing a service from start to finish. Matchmaker is designed to make production of service-client interfaces automatic across Banyan networks. Remote procedure calls permit a client to make a request from a provider called a *service.* In code, these requests are like local procedure calls, but the client and service provider are usually separate machines on a LAN or WAN.

The *VINES Application Developer's Reference* contains information about VINES resources, system limits, using Matchmaker, and detailed explanations of the basic 74 calls and 20 commands provided by the toolkit. The three interface references—mail, TCP/UDP, and X.25—contain detailed explanations of the interfaces and additional calls provided with each. Supporting the calls and commands of the toolkit is software that the administrator installs in the directory structure.

Banyan has been slow in providing adequate tools for third-party developers of Banyan-specific software. The company does have an Independent Developer's Assistance Program (IDAP) and publishes the *VINES Programer's Reference,* which provides information on the interface between DOS and VINES-resident software on the PC, but these tools and assistance have not allowed developers to write server-based applications.

To be competitive with Novell NetWare and Microsoft LAN Manager networks in the future, sophisticated APIs are critical. The Banyan API Toolkit is a well conceived attempt to rectify this situation. Banyan's Unix base may provide an inducement to the large pool of skilled Unix developers to work on Banyan-specific applications. For in-house corporate system developers, the APIs will be a welcome addition to Banyan's attractive features for corporate-wide systems.

—*Chet Schuyler*

throughput achieved for small transmissions between a workstation and a server. The previous table of many blocks is a better approximation of typical office automation utilization. The following are results for overlaid reads:

BLOCK SIZE (bytes)	THROUGHPUT (KB/s) AT	NOVELL	BANYAN
1	1	3	2
10	13	27	21
64	81	163	125
256	295	541	406
512	396	62	649
1,024	60	94	925
2,048	120	95	117
4,096	65	93	156

With six stations running LANPERF reading 64-block files, Novell and Banyan run very close. Individual station throughput dropped to about half that of an AT hard disk. Results for sequential reads with six PCs are as follows:

BLOCK SIZE (bytes)	THROUGHPUT (KB/s) NOVELL	BANYAN
1	39	19
10	380	185
64	159	232
256	163	202
512	165	224
1,024	218	206
2,048	187	225
4,096	259	229

PC Tech Journal's experience and that of many network users have pointed out that factors such as buffers defined on the PC, duration of the test period, and block size used in a test greatly influence the figures LANPERF delivers. The speed of sequential reads and writes on a Banyan 386-based server are certainly acceptable and on a par with Novell. (LANPERF is available for downloading from PCTECHline.)

Performance degradation on a Banyan network, as on a Novell network, is predictable and tolerable. In our testing, a Banyan server running version 3.0 crashed repeatedly running LANPERF. Upgrading to version 3.01 solved the problems. Yet, even in a crash, Banyan exhibits some redeeming qualities: a Banyan server crashes with a grace unheard of in LAN file servers. The server console displays a register dump and a message to type HELP to receive further assistance. Among the options offered are to dump server memory to disk, display registers, and reset the server.

After saving memory to disk, choosing RESET restarts the server. During the server's initialization, the system asks the operator whether or not to save the memory dump file to diskette. Once the server restarts, all service workstations can resume activities without rebooting or reconnecting to the network. This ability to reconnect is available even when a server has been powered down. Individual services on a Banyan server always can be shut down and restarted without disrupting other services.

A COMPANY'S PERFORMANCE

With the introduction of VINES/386, Banyan delivers a solid network operating system with many attractive features for firms looking for a big-system solution to their LAN needs. Banyan's integrated communications capabilities and StreetTalk naming service are its greatest strengths. The company provides a platform for WANs providing mail and communications services to a variety of hosts. Banyan's API toolkit offers in-house developers access to the Unix functions that underlie VINES, thereby greatly expanding the power of VINES for firms interested in doing their own network-specific development.

> *Banyan's API toolkit lets developers access Unix functions that underlie VINES, thereby greatly expanding the network's power.*

Banyan's technical strength should place it in the first rank of LAN vendors, but the company's estimated 1988 sales of $45 million seem modest compared with Novell's estimated $250 million. Banyan has suffered from weak marketing and underdevelopment of distribution channels. It is a small firm with fewer than 400 employees and a relatively small dealer base of about 100. It is fair to ask whether Banyan can meet the multiple development needs for LANs in the near future. For example, Banyan has backed away from a stated goal of supporting OS/2 workstations in the first quarter of 1989 to stating that OS/2 support will come at some future date. Banyan is working with Oracle Corporation to develop an SQL server implementation, but has announced no definite date.

On the other hand, Banyan already has many installations of several hundred PCs. Continental Grain has 10 servers in New York with more than 350 stations, a 56KB satellite connection to two servers in Geneva, Switzerland, and two 3270 SNA gateway connections to its mainframe in Chicago. The gateways are used not only by the New York staff: the Geneva users sign on to the Chicago host through the New York LAN simply by invoking the 3270 program on their PCs. Larry Stouder, Information Center Manager for Continental Grain, says the gateway has performed well under heavy use.

Potential customers must weigh these strengths and weaknesses against those of the competition. Novell, for example, has made gains in its communications capabilities and significant improvements in its gateway products. NetWare is a strong operating system with many large installations running. Moreover, Novell long ago opened the doors to third-party developers (see "Developing for NetWare," Ralph Davis, August 1988, p. 108) and, as market leader, has attracted significant development effort from outside software and hardware developers. Banyan plans to release its own APIs this year.

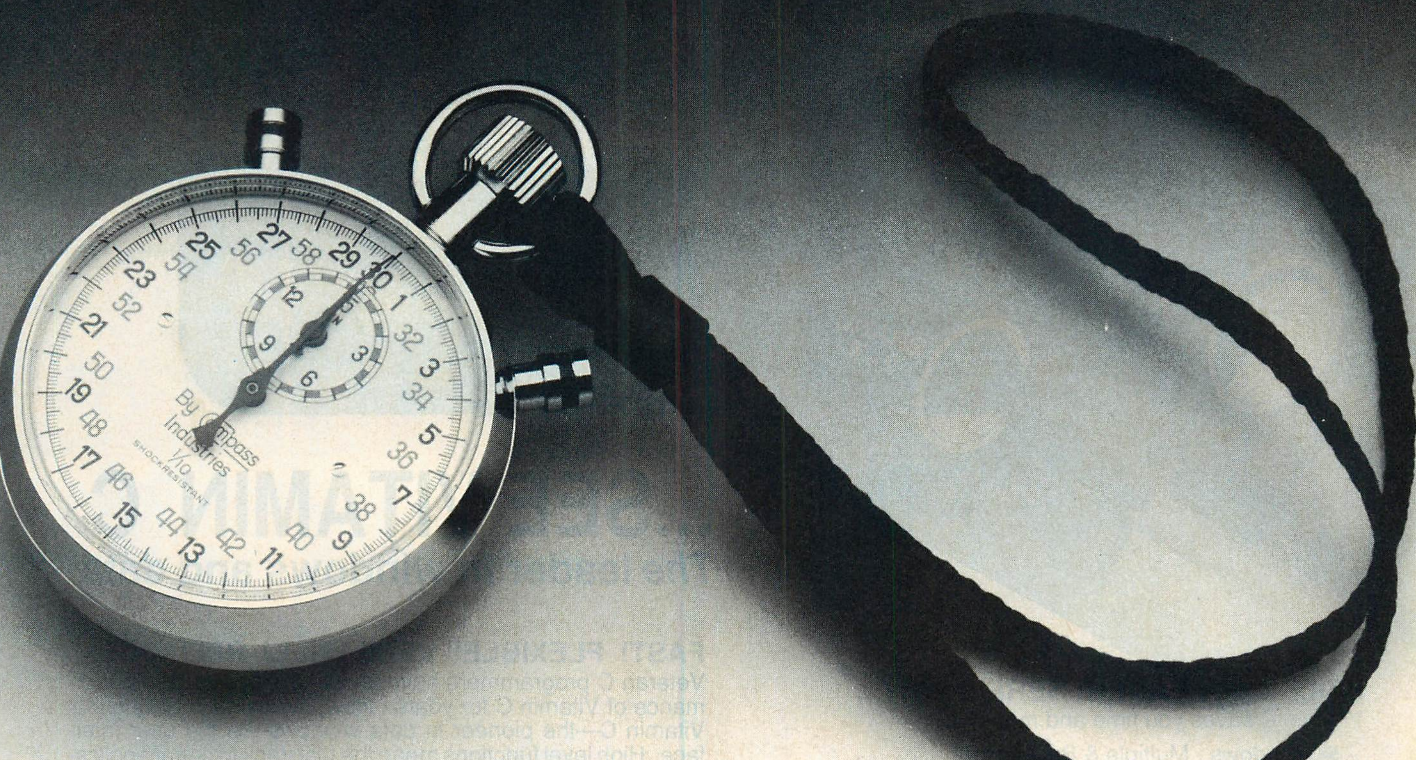
In addition, Microsoft's OS/2 LAN Manager will be a force in the LAN marketplace. The choices are difficult, but Banyan's distinctive communications and connection capabilities are attractive, and if a good dealer with a proven track record is available, Banyan is a strong contender in the LAN purchase decision.

Banyan has consistently marketed a technically sophisticated product, delivering WAN capabilities, resource sharing, and an integrated resource-naming system. Its entire line is targeted for the high-end LAN market—multiserver, geographically dispersed LANs with extensive connectivity needs among dissimilar systems. Banyan networks admirably meet the needs of the target audience by offering reliable, integrated communications services along with a solid LAN operating system.

Banyan Systems Incorporated
115 Flanders Road
Westboro, MA 01581
508/898-1000
BNS; CNS; DTS; VINES/286; VINES/386 (For pricing, see table 2, p. 118.)
CIRCLE 359 ON READER SERVICE CARD

Brice Bonwill is president of System and Network Solutions, a Virginia-based consulting firm specializing in total network integrating solutions for PC LANs, including connections to mainframes and systems software. He has installed numerous Banyan networks using multiple topologies. He also has installed Novell and 3Com networks.

THERE ARE FOUR WAYS TO MEASURE THE SPEED OF A LAN.



Ours only wins in three of them.

1. How fast does it install.

We have no competition in this category. LANLink 5X installs in about fifteen minutes, and it doesn't take a technician to do it. Since LANLink 5X uses standard parallel or RS-232 serial ports, installing a network means little more than connecting the cable and loading the software.

With hardware LANs, installation can easily take two days–one to set it up and one to tweak it. And it also takes someone who really knows what he's doing. That is, someone expensive.

2. How fast does it transmit.

Okay, this is the category we don't win; the hardware LANs are generally a little quicker. At least, they are under optimal conditions, which is how they rate themselves.

But LANLink 5X is pretty quick, too. At half a megabit per second, it's way out ahead of any other software LAN, and right at the heels of the hardware types. Which, of course, are far more expensive.

3. How fast does it maintain.

The real cost of a network is not so much the initial price as it is the continuing outlay for maintenance–adapting it to changing needs. That's something LANLink 5X does practically on its own. Running under PC-MOS/386™ or PC-DOS, it turns your server PC into a multi-tasking controller, driving a truly expandable LAN that is easily and quickly upgradable.

A hardware LAN, on the other hand, becomes obsolete as new technology is introduced. And, to keep the network up and running as applications change, you need the attentions of a technician, on a continuing basis. A very well-paid technician.

4. How fast can you pay for it.

Now we've arrived at the bottom line, where LANLink 5X is toughest to beat. You can install a five-user LANLink network for about the same cost as the LAN board in a board-driven network. On top of that, factor in what you save on installation and maintenance time, and the difference is pretty dramatic.

LANLink 5X is available immediately, and it comes with a money-back guarantee. Its price of $595 includes a server and a satellite module plus the network operating system. Additional satellites are available for $125.

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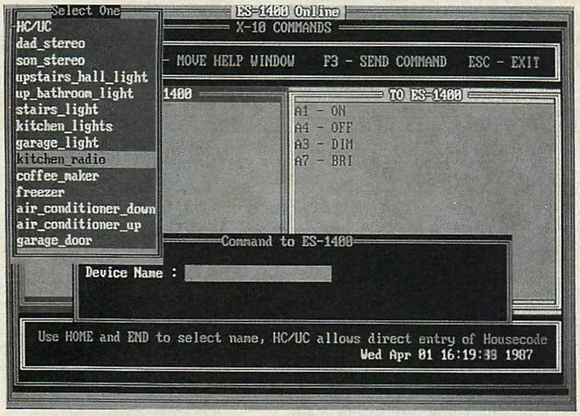

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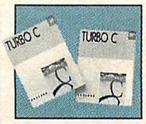

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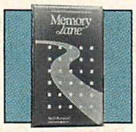
Borland International



MEMORY LANE 2.0
Group L Corporation

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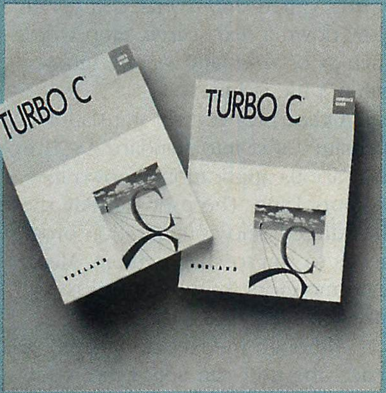


CIRCLE 349 ON READER SERVICE CARD

Turbo C 2.0 from Borland International is a complete C development package for the systems developer. Particularly strong graphics support and a new source-level debugger should remove any final objections professional developers may have had to working with Turbo C. (For a review of version 1.5 of Turbo C, see "Turbo and Quick Weigh In," Marty Franz, February 1988, p. 72.)

The integrated environment includes a debugger, C compiler, make utility, C preprocessor, librarian, an extensive library of functions including those in Unix and the ANSI draft standard, and a stand-alone, Help program.

The language implementation follows the emerging ANSI standard very closely, although the documentation places more emphasis on the Kernighan and Ritchie definition, detailing the extensions to that generally accepted textbook standard. Turbo C supports all six memory models specific to 80*x*86 processors (including the tiny model for .COM programs) and the key words **near**, **far**, and **huge** for mixed-model programming. The package uses the non-ANSI key word **interrupt** for interrupt handlers.

In the library of include files and function calls, the most important ANSI extension that is not implemented is *localization*, which allows a C program to specify, for example, that currency amounts be formatted in accordance with the conventions of a particular country. This is one of the more volatile parts of the ANSI C standard; many C-library implementers have adopted a wait-and-see attitude. Borland supplies the Unix function calls applicable to DOS that are not in the ANSI C standard, as well as a complete interface to DOS and BIOS services and support for writing interrupt handlers in C. These are standard components of any serious C-compiler package.

The Borland C compiler includes an outstanding package of graphics functions. Instead of providing only the customary support for CGA, EGA, MCGA, and VGA, Turbo C has incorporated routines that allow the developer to use the capabilities of Hercules, AT&T, PC3270, and 8514 graphics adapters. Moreover, these graphics functions are hardware-independent. The Turbo C library can detect which adapter is present, the maximum horizontal and vertical resolution, and color capability of the system. If you ever again are faced with a program that asks whether you have a Hercules board or an EGA, you will know that its developer did not use Turbo C.

The integrated environment is based on a WordStar-like editor, which can be configured to some extent, but which allows only one window onto the user's source code. Single keystrokes activate menus for controlling the built-in make utility, compiler, linker, and debugger; they also access help for any of these components or for any function in the library.

Many professional developers probably will prefer to use a separate editor over the limited editor of the integrated environment. This choice is supported by stand-alone versions of the compiler and linker and by a make utility that is more powerful than the make utility in the integrated environment. A good program editor can integrate these into its own environment by means of macros.

The debugger, new to version 2.0, allows the developer to set breakpoints and watch expressions (whose current value is displayed in a separate window) and two modes of source-level tracing (one mode treats a function call as a single step, the other mode traces into the function). Like other debuggers, it allows the developer to switch between the screen generated by the program under test and the screen that contains the debugger information. This works flawlessly, even when the program generates output in graphics modes not supported by DOS, including the Hercules graphics mode.

The stand-alone Turbo Debugger, sold with the Turbo C Professional package ($250), provides more powerful debugging capabilities than the debugger in the integrated environment. A useful additional utility for this do-it-yourself environment is a memory-resident program called THELP, which displays information for any function in the library with a hot-key combination. (For a complete review of Turbo Debugger, see "Turbo Debugging," Ben Myers, January 1989, p. 46.)

Compilation and execution performance is a vital consideration for developers, and Turbo C is among the best. On compilation benchmarks with maximum optimization, Turbo C typically compiles a program three times faster than Microsoft C. Compilation

speed actually improved by about 10 percent over version 1.5, despite addition of the integrated debugger.

The code generated is virtually unchanged (see "Highly Polished C Code," Philip N. Hisley, June 1988, p. 76). The only exception is a slight improvement in long arithmetic. Thus, on CPU-intensive benchmarks, Turbo C still falls behind Microsoft C 5.0 and WATCOM C, but is slightly faster than Microsoft QuickC. In the runtime library, Turbo C file I/O functions are about 25-percent faster than version 1.5, moving it ahead of WATCOM C and Microsoft C in this area.

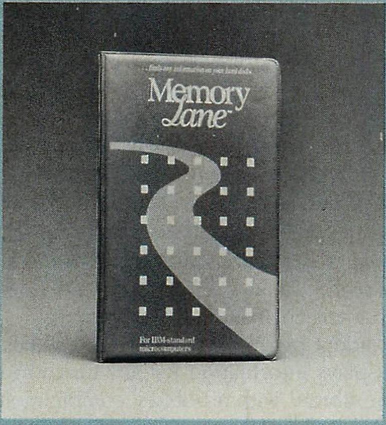
Turbo C 2.0 is a good choice for the professional developer, and it retains its attractions for the newcomer to C. Its integrated debugger is a welcome addition, although some may wish to supplement it with the stand-alone Turbo Debugger for the capability of placing a breakpoint on a change in an expression. For developers of software that use graphics, Turbo C is particularly appealing because of its painless support of a wide range of graphics adapters. This support, along with its integrated debugger, puts Turbo C 2.0 far ahead of the pack.

—NICK JACOBS

MEMORY LANE 2.0

Group L Corporation
481 Carlisle Drive
Herndon, VA 22070
800/672-5300; 703/471-0030

PRICE: $99



CIRCLE 350 ON READER SERVICE CARD

Sifting through tens of megabytes of data on a hard disk to find a particular phrase or portion of text buried in a file can be tedious. These situations will only become more frequent as larger hard-disk drives become more common.

Group L Corporation has developed an efficient solution to this problem—Memory Lane 2.0, a terminate-and-stay-resident (TSR), text-indexing program for hard disks.

A hot key accesses Memory Lane from DOS or applications. From the main menu, the user enters the text to be located and selects the files or groups of files to be searched. The appropriate keystrokes also invoke a search of unindexed files.

As Memory Lane searches, it lists the names of the files that have successful matches, called *hits*. Once the search is complete, the user can browse these files by positioning a display window on the desired text. Phrases can be copied from these displays and placed into other files. Memory Lane can translate between file formats such as dBASE, WordPerfect, Microsoft Word, and IBM DisplayWrite. This translation is automatic when the text is retrieved.

Memory Lane also creates sets, called *folders*, of logically related files that are useful for creating views of content-oriented files. These files can share a common feature, such as being created with Microsoft Word or containing common text patterns. Folders are independent of the directory structure of the indexed disk; they correspond to Memory Lane's index. They can span directories and include all files that may contain references to certain projects.

The search text does not have to be kept in special directories; the software will search whatever directory organization it encounters on a disk. Memory Lane will index and search only on standard ASCII text and numeric characters, however, and searches are not case sensitive.

Several options are available for searching. Memory Lane recognizes a wild-card symbol, matching any single word (in a phrase) or combination of characters combined with an explicit text fragment. The product also offers proximity searches.

OR and AND relationships between search criteria are also possible. The main menu allows entry of as many as three phrases that have an OR relationship. Locating files with an AND criterion between the search phrases is more complicated and requires successive searches to locate all phrases.

The Memory Lane menu guides the user to many administrative options, including which files to index, limiting searches to files in certain subdirectories or to those created before or after a certain date, and monitoring directories for new or updated files. In the latter case, the software automatically reindexes those files or prompts the user to invoke the index function.

Automatic indexing sounds useful, but in practice, it is overbearing. After a file is updated or edited and the application exits to DOS, the automatic indexer engages, monopolizing the machine for about a minute while it creates the index. Fortunately, user-controlled indexing is the default.

Group L's design of Memory Lane is well thought out. For example, the package includes a set of control files that outline some basic parameters about how the software operates. One file contains entries that tell Memory Lane which files to ignore and which to monitor for changes. The default collection ignores .EXE and .COM files. Another file lists frequently occurring words, called *stop words*, that greatly slow down a text search. Stop words such as *of*, *and*, and *the* are ignored when a file is indexed.

Other files control translations of formatted text into standard ASCII from the various applications known to Memory Lane. The user can edit these files directly; no configuration program needs to run to change them. Memory Lane monitors these files and recognizes changes immediately.

Although indexes do take up disk space, the user can adjust the index size by trading size for access speed. The index size can be either 15 or 30 percent of the total amount of data. The 15-percent level results in slower search speeds, but can index 30MB of data; the 30-percent level can index 16MB of data and provides the fastest searches.

In tests at 15-percent overhead, the indexes for 5.2MB of data files require 826KB of memory and take 20 minutes to create on a 12-MHz AT-compatible system with a Seagate ST-225 hard disk. Searches in 5.2MB of data are quick. Memory Lane locates files containing a single word in 40 seconds. Longer phrases require less time (less than a few seconds), while wild-card and proximity searches take longer.

Memory Lane is good at what it is designed for: helping users organize and locate information on hard disks. Many PC users will find the product useful. It saves time and alleviates frustration by helping users organize files with a minimum of effort.

—PAUL FIRGENS

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TED MIRECKI

TECH NOTEBOOK

A forum for sharing solutions to technical problems

1 USING EMS

Although the use of the expanded memory specification (EMS) is prevalent in systems software (witness Microsoft Windows, Quarterdeck's DESQview, and the plethora of RAM-disk and caching utilities), it is not as widely used by applications. The reason for this is that EMS requires low-level capabilities such as software interrupts and access to memory at arbitrary locations outside of the address space managed by DOS (see "EMS 4.0 Pulls Together," Ted Mirecki, July 1988, p. 72).

These capabilities are readily available in low-level languages used for systems software (assembly and C), but are difficult or impossible to implement in higher-level languages used for scientific and business applications. One of the purposes of EMS, however, is to expand the data space available to DOS programs, and some of the most data-intensive applications are scientific ones typically written in a high-level language such as FORTRAN.

This month's column presents one example of an EMS interface for a compiled language, FORTRAN (tested with Microsoft's version 4.1). Many scientific programs written in FORTRAN need to manipulate large amounts of data in memory. The procedures, however, can be called from other Microsoft languages and are easily adaptable to any compiler with a documented function-calling protocol. EMS 4.0 is required.

1 AN EMS PACKAGE FOR FORTRAN

The programming interface to EMS allows the allocation and mapping of expanded memory in 16KB pages. This is not a particularly good unit for high-level applications, so one function of a high-level language interface is to allow the manipulation of memory in more useful units. The example given here operates on blocks of memory of any size convenient to the calling program. The blocks can be moved between expanded memory and the program's data space, but all processing of data must take place in conventional memory. EMS is used only as a temporary repository for data so that the program can reuse the data space for other purposes. The concept is similar to saving data in a temporary file on disk, but with the advantage that the transfers to and from EMS proceed at least an order of magnitude faster.

Because these blocks must originate in and return to conventional memory, the size of a block cannot exceed that which fits into the program's data space. The minimum size is one byte, but each block is stored in an integral number of 16KB pages, so small blocks waste memory. This EMS interface is not intended for simulating a record-oriented file in expanded memory (for that, use a RAM disk); rather, it is intended for transferring entire arrays that take up several pages.

Another issue not addressed by this implementation is the processing of arrays that are too large to fit in the data space in conventional memory. A virtual-array EMS interface for that purpose will be presented in a future Tech Notebook.

Two assembly-language source files demonstrate the EMS interface. EMSSUBS.ASM (listing 1) contains procedures that are generally useful with any organization of EMS memory, while the procedures in EMBSUBS.ASM (listing 2) implement the functions that are specifically block-oriented. All of the procedures are written for the huge memory model and for the calling sequence of Microsoft FORTRAN. Function arguments are passed by reference (using far addresses) and are pushed in left-to-right sequence, so that at entry to the procedure, the address of the last argument in the calling sequence is closest to the stack pointer.

The first step in using expanded memory is finding out if it is present. EMS requires two components: hardware to map pages into the system address space and a device driver called the Expanded Memory Manager (EMM) to manipulate the hardware in response to EMS requests from programs. To an application program, the presence of the EMM is sufficient to establish the presence of EMS hardware, because the device driver will not install itself at system initialization time if the required hardware (an 80386 processor or an EMS board) is not available.

The function EMSVER (see listing 1) tests for the presence of the EMM using the interrupt-vector method. EMSVER obtains the INT 67H vector and scans the device name at offset 10H of the segment to which the vector points. The EMM is present if the string at that address is EMMXXXX0. If the EMM is found, EMSVER determines the base address of the primary page frame and saves it in a global variable in the default data segment. Although not used by the block interface functions, this value is necessary in other EMS access methods. Saving the address makes EMSVER generally useful beyond this implementation.

The EMSVER function takes no arguments and returns an INTEGER*2 (16-bit) value representing the EMS version number supported by the EMM, or 0 if the EMM is not installed. It also saves the return value in another global variable, so that subsequent EMS interface routines can determine the presence of the EMM without repeating the test. The version number is initially −1, so if another procedure finds this value, it knows that the presence of EMS was never tested.

The version number is expressed as two binary-coded decimal digits; the high-order digit is the integer part of the version number, and the low-order

digit is the fraction part. For example, EMS 3.2 returns 32H. If the calling program needs the version number in a form that can be displayed, it must extract the two digits from the returned value by obtaining a quotient and remainder modulo 16.

The second step in using EMS is to allocate a block consisting of a number of 16KB pages. Each successful allocation request returns an *EMS handle*, a 16-bit value identifying that block. The function that implements this is EMBALO (see listing 2). Its parameters are an INTEGER*4 (32-bit) value indicating the number of bytes to allocate and an INTEGER*2 value to receive the returned handle number. The function returns an INTEGER*2 error code; 0 indicates that the allocation request succeeded.

Most of the error codes returned by EMBALO and the other block-interface EMS functions are the same as the codes defined by the EMS documentation (see table 1). Values below 128 are used for error conditions that the EMM does not detect, such as the absence of the EMM. You must declare the functions as integer types, either explicitly or by IMPLICIT statements, because their names do not follow the FORTRAN implicit typing conventions. As a safety precaution, the returned values are valid whether the functions are declared INTEGER*2 or INTEGER*4.

TABLE 1: ***EMM Error Codes from Interface Routines***

ERROR CODE	DESCRIPTION
126 (7EH)	Invalid size (nonpositive)
127 (7FH)	EMM driver not installed
128 (80H)	EMM software malfunction
129 (81H)	EMS hardware malfunction
131 (83H)	Invalid handle ID
132 (84H)	Invalid EMM function
133 (85H)	No handles available
135 (87H)	Page request exceeds installed pages
136 (88H)	Page request exceeds free-page count
138 (8AH)	Page number exceeds handle's page count
139 (8BH)	Invalid physical-page frame

Error codes greater than 127 are the same as defined in EMS. The others are extensions to handle situations specific to this high-level language interface.

EMBALO checks the EMS version number saved by EMSVER. A value of 0 indicates that the EMM is not installed; in this case, EMBALO returns an error. If the value is −1, then EMSVER was never called, and EMBALO calls it to test for the presence of EMS. Any other value is taken as confirmation that the EMM is present and operational.

The size parameter to EMBALO specifies the requested block size in bytes, not pages. The function, however, allocates integral pages by rounding the requested size up to the next higher page boundary. If insufficient pages are available to satisfy the request, EMBALO returns an error code of 135 or 136 and sets the value of the

size parameter to the amount in bytes of the expanded memory available. By calling EMBALO with an impossibly large value (the absolute upper limit on expanded memory is 32MB), a program can determine the amount of free memory available. Note that the size parameter cannot be a constant because it is subject to modification.

The two routines EMBPUT and EMBGET (see listing 2) implement the actual moving of data between expanded and conventional memory. The three parameters to each routine are a variable identifying a location in conventional memory, an INTEGER*4 length in bytes, and an INTEGER*2 EMS handle identifying an EMS block. The first parameter is typically an array name, but may also be an array element or a variable in a common block. The return value is one of the error codes from table 1; parameter values are never modified. Both functions check whether EMSVER had been called to establish the presence or absence of the EMM; this precaution prevents system crashes caused by calls to a nonexistent INT 67H handler.

The address and length parameters passed to EMBGET need not be the same as those on a previous call to EMBPUT for the same handle—you can read back a smaller amount and place it in a new location. Note, however, that any data not read on one request can be obtained only by rereading all data from the beginning of the block.

The final action that a program must take on an EMS block is to release it when no longer needed. Otherwise, the block becomes stranded and unavailable to any other process.

The EMSDEL function (see listing 1) deallocates a block of expanded memory. The only parameter is the handle; the return value is the error code. The EMSDEL function is generally useful in any EMS interface implementation, not only in the block-oriented implementation.

EMBDEMO.FOR, a FORTRAN driver program to demonstrate the operation of the EMS routines, is available on PCTECHline. It moves an array (filled with constants) to expanded memory, moves it back to a different location, and compares the moved array with the original. A make file, EMB.M, is also provided on PCTECHline for building the executable file. You may need to modify it if you use tools other than Microsoft development tools.

This block-oriented EMS interface is simple-minded, but it can be of practical use in many programs that would otherwise use disk files for temporary data storage. EMS 4.0 has the capability of supporting more sophisticated access methods. For example, the EMM function used in EMBGET and EMBPUT to effect the actual transfer to or from expanded memory allows specifying a boundary other than the beginning of the expanded-memory block. This boundary, however, must be specified by page number and offset within the page; this is not a particularly useful addressing scheme for high-level languages that deal with data as multidimensioned arrays or other abstract structures. Fine-grained access to expanded memory is most useful if it is specified in the same terms that the language uses to access conventional memory. This, however, is a subject for a future Tech Notebook.

LISTING 1: EMSSUBS.ASM

```
; EMSSUBS - Common EMS interface for high-level languages.
; Copyright (c) 1989 PC TECH Journal and Ziff-Davis Publishing Co.
; Written by Ted Mirecki
; Designed for Microsoft FORTRAN, but easily convertible to
; other compilers & languages.


         .MODEL  LARGE
         .DATA
         PUBLIC  __FRAMSEG, __EMSVER
__FRAMSEG DW     0                ;PAGE FRAME SEGMENT ADDRESS
__EMSVER  DW     -1               ;-1 = PRESENCE NOT TESTED
                                  ; 0 = EMM NOT INSTALLED
         .CODE
; ==================================================================
; EMSVER - Determine if EMM installed, return version no.,
;          save page frame segment address for future use.
;
; FORTRAN SPECIFICATION:
;     INTEGER*2 FUNCTION EMSVER()
;          RETURNS 0 IF EMM NOT INSTALLED, ELSE VERSION NO. AS 2 BCD
;          DIGITS.  (I.E. MAJOR VERSION*16 + MINOR VERSION).
; ==================================================================
         PUBLIC  EMSVER
EMSVER   PROC
         PUSH    ES
         MOV     AX,3567h         ;GET INT67 VECTOR IN ES:BX
         INT     21h
         MOV     DI,10            ;ES:DI->NAME OF INT67 DEVICE
         PUSH    DS
         MOV     AX,CS            ;SET DS TO CODE SEGMENT
         MOV     DS,AX            ;DS:SI->EMM NAME STRING
         MOV     SI,OFFSET DEVNAME
         MOV     CX,8             ;LENGTH OF NAME
         REPE    CMPSB            ;COMPARE NAMES
         POP     DS
         JE      EMSVER1          ;DID WE FIND EMM DEVICE?
         XOR     AX,AX            ;NO: RETURN ZERO VALUE
         JMP     SHORT EMSVERX
EMSVER1:
         MOV     AH,46h           ;YES: GET ITS VERSION NO.
         INT     67h              ;EMM CALL
         XOR     AH,AH            ;EXPAND VERSION IN AL TO WORD
         PUSH    AX               ;SAVE IT
         MOV     AH,41h           ;GET PAGE FRAME ADDRESS
         INT     67h
         MOV     __FRAMSEG,BX
         POP     AX
EMSVERX:
         MOV     __EMSVER,AX      ;MARK THAT WE'VE BEEN HERE
         XOR     DX,DX            ;RETURN DWORD, JUST IN CASE
         POP     ES
         RET
EMSVER   ENDP
DEVNAME  DB      'EMMXXXX0'

; ==================================================================
; EMSDEL - Deallocate EMS pages for specified ID
;
; FORTRAN SPECIFICATION:
;     INTEGER*2 FUNCTION EMSDEL(ID)
;     INTEGER*2 ID - Handle ID
; Returned function value is EMM error code
; ==================================================================
         PUBLIC  EMSDEL
EMSDEL   PROC
         PUSH    BP               ;ESTABLISH STACK FRAME
         MOV     BP,SP
         PUSH    DS
         MOV     AX,83h           ;INVALID ID ERROR
         CMP     __EMSVER,0       ;IS EMM THERE?
         JBE     EMSDELX          ;NO, OR NOT TESTED: EXIT W/ERROR
         LDS     BX,[BP+6]        ;GET ARG ADDRESS
         MOV     DX,[BX]          ;GET ARG VALUE
         MOV     AH,45h           ;EMS DEALLOCATE FUNCTION
         INT     67h
         MOV     AL,AH            ;ERROR CODE FROM AH TO WORD IN AX
         XOR     AH,AH
EMSDELX:
         XOR     DX,DX            ;RETURN DWORD VALUE, JUST IN CASE
         POP     DS
         POP     BP
         RET     2
EMSDEL   ENDP
         END
```

LISTING 2: EMBSUBS.ASM

```
; EMBSUBS - EMS Block-transfer interface for high-level languages.
; Copyright (c) 1989 PC TECH Journal and Ziff-Davis Publishing Co.
; Written by Ted Mirecki
; Designed for Microsoft FORTRAN

          EXTRN   __FRAMSEG:WORD, __EMSVER:WORD, EMSVER:FAR
          .MODEL  LARGE
          .CODE
; ===================================================================
; MACRO TO GENERATE STANDARD ENTRY SEQUENCE FOR BLOCK ROUTINES:
; GENERATE STACK OFFSET OF ARGUMENTS,
; TEST FOR PRESENCE OF EMM IF NOT DONE PREVIOUSLY, SET UP STACK FRAME
; ===================================================================

EMB_ENTRY MACRO   NARGS
          LOCAL   RETEST, YES, MAYBE
          N = 1                   ;ARGUMENT COUNTER
          OFFSETN = NARGS*4 + 2   ;OFFSET FROM BP OF NTH ARGUMENT
          REPT    NARGS
            EQAT  %N, %OFFSETN    ;GENERATE EQUATE: ARGN = OFFSETN
            N = N + 1
            OFFSETN = OFFSETN - 4
          ENDM
RETEST:
          CMP     __EMSVER,0      ;IS EMM INSTALLED?
          JA      YES             ;YES, CONTINUE
          JB      MAYBE           ;DON'T KNOW: LET'S FIND OUT
          MOV     AX,127          ;NO: EXIT W/ERROR CODE
          RET
MAYBE:    CALL    EMSVER
          JMP     RETEST
YES:      PUSH    BP              ;SET UP STACK FRAME
          MOV     BP,SP
          PUSH    DS              ;[BP-2]
          PUSH    SI              ;[BP-4]
          ENDM

EQAT      MACRO   XX, WHERE
          .LALL
          ARG&XX = WHERE
          .XALL
          ENDM

EMB_EXIT  MACRO   ARGBYTES
          XOR     DX,DX                   ;RETURN DWORD ERROR, JUST IN CASE
          POP     SI                      ;RESTORE REGS
          POP     DS
          POP     BP
          RET     ARGBYTES
          ENDM

; ===================================================================
; EMBALO - Allocate EMS block of requested number of bytes
;
; FORTRAN SPECIFICATION:
;      INTEGER*2 FUNCTION EMBALO(NBYTES, ID)
;      INTEGER*4 NBYTES
;      INTEGER*2 ID     - Returned EMS handle for allocated memory
;      Function value is 0 if successful, else EMM error code
;      If error is "insufficient memory to satisfy request,"
;      returned value of NBYTES is max EMS memory available.
; ===================================================================
          PUBLIC  EMBALO
EMBALO    PROC
          EMB_ENTRY  2                    ;TAKES 2 ARGUMENTS

          LDS     SI,[BP].ARG1            ;GET ADDRESS OF LENGTH PARAMETER
          MOV     AX,[SI]                 ;GET DWORD VALUE INTO DX:AX
          MOV     DX,[SI+2]
          MOV     BX,3FFFh                ;ROUND UP TO NEXT 16KB
          ADD     AX,BX
          ADC     DX,0
          INC     BX
          DIV     BX                      ;CALC NUMBER OF 16KB PAGES
          MOV     CX,AX                   ;SAVE THE QUOTIENT
          MOV     AX,126                  ;ERROR CODE FOR INVALID LENGTH
          CMP     CX,0                    ;TEST IF VALID PAGE COUNT
          JLE     EMBALOX                 ;ERROR IF .LE. 0

          MOV     AH,42h                  ;DETERMINE FREE PAGE COUNT
          INT     67h
          MOV     AL,AH                   ;CONVERT ERROR CODE TO WORD
          AND     AX,0FFh
          JNZ     EMBALOX                 ;EXIT IF IT'S NOT 0
          CMP     BX,CX                   ;TEST REQUESTED VS. AVAILABLE
          JAE     EMBALO2                 ;OK IF AVAIL >= REQUESTED
          MOV     AX,BX                   ;ELSE CALC AVAIL BYTES
          MOV     BX,4000h                ;BYTES = PAGES * 16KB
          MUL     BX
          MOV     [SI],AX                 ;RETURN ACTUAL BYTE COUNT
          MOV     [SI+2],DX
          MOV     AX,88h                  ;ERROR CODE FOR LACK OF MEMORY
          JMP     SHORT EMBALOX
EMBALO2:  MOV     BX,CX
          MOV     AH,43h                  ;ALLOCATE PAGES
          INT     67h
          MOV     AL,AH                   ;CONVERT ERROR CODE TO WORD
          AND     AX,0FFh
          JNZ     EMBALOX                 ;EXIT IF IT'S NOT 0
          LDS     SI,[BP].ARG2            ;GET ADDRESS OF ID PARAMETER
          MOV     [SI],DX                 ;RETURN ID VALUE
EMBALOX:
          EMB_EXIT 8
EMBALO    ENDP

; ===================================================================
; STRUCTURE THAT HOLDS PARAMETERS FOR EMS BLOCK MOVE FUNCTION.
; MACRO TO FILL THE STRUCTURE DEPENDING ON DIRECTION OF MOVE.
; ===================================================================

EMS_MOV   STRUC
LEN_LO    DW      ?                       ;DWORD BYTE COUNT OF MOVE
LEN_HI    DW      ?
SRC_TYPE  DB      ?                       ;1=SRC IN EMS, ELSE CONVENTIONAL
SRC_HAN   DW      ?                       ;EMM HANDLE IF SRC IN EMS
SRC_OFF   DW      ?                       ;DWORD ADDRESS OF SOURCE
```

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*Source: PC Week, Nov. 14, 1988.

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```
SRC_SEG     DW      ?
DES_TYPE    DB      ?               ;REPEAT ABOVE FOR DESTINATION
DES_HAN     DW      ?
DES_OFF     DW      ?
DES_SEG     DW      ?
EMS_MOV     ENDS

EMS_CONV    MACRO   EMS, CON

            SUB     SP,TYPE EMS_MOV     ;ON-STACK SPACE FOR STRUCTURE

            XOR     AX,AX               ;SET ADDRESS IN EMS MEMORY:
            MOV     [BP+SBASE].&EMS&_SEG,AX  ;FIRST PAGE
            MOV     [BP+SBASE].&EMS&_OFF,AX  ;ZERO OFFSET WITHIN IT
            MOV     [BP+SBASE].&EMS&_TYPE,1  ;TYPE = EMS
            LDS     SI,[BP].ARG3             ;GET HANDLE ID
            MOV     DX,[SI]
            MOV     [BP+SBASE].&EMS&_HAN,DX

            LDS     SI,[BP].ARG1        ;SET UP ADDRESS IN CONV MEM:
            MOV     [BP+SBASE].&CON&_OFF,SI
            MOV     [BP+SBASE].&CON&_SEG,DS
            MOV     [BP+SBASE].&CON&_TYPE,AL ;TYPE = CONVENTIONAL
            MOV     [BP+SBASE].&CON&_HAN,AX  ;HAS NO HANDLE ID
            ENDM

SBASE = -(TYPE EMS_MOV + 4)        ;OFFSET OF STRUCTURE FROM BP

; ===================================================================
; EMBPUT, EMBGET - Copy a block of memory to/from EMS memory
;
; FORTRAN SPECIFICATION:
;       INTEGER*2 FUNCTION EMBPUT(ARR, NBYTES, ID)
;       INTEGER*2 FUNCTION EMBGET(ARR, NBYTES, ID)
;       anytype ARR(*)
;       INTEGER*4 NBYTES
;       INTEGER*2 ID
;       Function return value is EMS error code, 0 = no errors.
; ===================================================================
            PUBLIC  EMBPUT, EMBGET
EMBPUT      PROC
            EMB_ENTRY  3            ;TAKES 3 ARGUMENTS
            EMS_CONV   DES,SRC      ;EMS <-- CONV
            JMP     SHORT GETPUT
EMBPUT      ENDP

EMBGET      PROC
            EMB_ENTRY  3
            EMS_CONV   SRC,DES      ;EMS --> CONV
EMBGET      ENDP                    ;FALL INTO COMMON CODE

GETPUT      PROC
            LDS     SI,[BP].ARG2    ;ADDRESS OF LENGTH
            MOV     CX,[SI]         ;DWORD LENGTH VALUE TO BX:CX
            MOV     BX,[SI+2]
            MOV     AX,126          ;INVALID LENGTH ERROR
            CMP     BX,0            ;TEST IF HI WORD >= 0
            JL      GETPUTX         ;ERROR IF  < 0
            JG      GETPUT1         ;OK IF > 0
            OR      CX,CX           ;IF HI WORD = 0, TEST LO WORD
            JZ      GETPUTX         ;ERROR IF BOTH ZERO
GETPUT1:
            MOV     [BP+SBASE].LEN_LO,CX
            MOV     [BP+SBASE].LEN_HI,BX
            MOV     AX,SS
            MOV     DS,AX
            LEA     SI,[BP+SBASE]   ;DS:SI -> STRUCTURE ON STACK

            MOV     AX,5700h        ;EMS MOVE BLOCK FUNCTION
            INT     67h
            MOV     AL,AH           ;CONVERT BYTE ERROR CODE IN AL..
            AND     AX,0FFh         ;TO WORD IN AZ
GETPUTX:
            ADD     SP,TYPE EMS_MOV;RELEASE LOCAL STACK SPACE
            EMB_EXIT 12
GETPUT      ENDP
            END
```

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GSS CGI....*Device independent graphics*	495	425
BASIC		
Microsoft BASIC Interpreter..*for XENIX*	350	249
Microsoft QuickBASIC...*Ver 4.0*	99	66
Turbo BASIC.......*NEW from Borland*	100	75
BASIC LIBRARIES & UTILITIES		
Btrieve Softcraft's File Manager	245	179
GSS CGI....*Device Independent Library*	495	425
Halo Graphics by Media Cybernetics	325	249
C LANGUAGE COMPILERS		
C86 PLUS by Computer Innovations	497	397
Lattice C Compiler Now ver 3.2	450	299
Let's C Compiler from Mark Williams Co	75	55
Mark Williams C full development system	495	369
Microsoft C Compiler with free CODEVIEW	450	295
Microsoft QuickC....*Special Price*	99	66
Turbo C.......*New from Borland*	100	75
C LIBRARIES—Communications		
Asynch Manager by Blaise	175	135
Greenleaf Communications	185	139
Essential Communications	185	125
Essential Communications Plus	310	239
C LIBRARIES—FILE MANAGEMENT		
Btrieve Softcraft's File Manager	245	179
Btrieve/N File Management for Networks	595	449
Ctree by Faircom,with full source	395	299
Rtree...*Report Gen. for Ctree*	295	235
Ctree & Rtree.....*Special Combination*	650	499
dBC ISAM Accesses dBase files	250	175
with Source code	500	349
dBC III Plus multiuser	750	595
with Source code	1500	1195
Opt Tech Sort Super fast sort for Btrieve	149	105
XQL....SQL *from NOVELL*	795	595
C LIBRARIES—Graphics		
Essential Graphics...*no royalties*	299	225
GSS CGI....*Device independent graphics*	495	425
GSS Metafile Interpreter stores images	295	265
Halo '88 by Media Cybernetics	325	249
Halo for Microsoft Languages	595	434
C LIBRARIES—Screen Design		
Curses from Lattice,UNIX lookalike	125	99
with source	250	199
C Worthy....*by Custom Design Systems*	195	159
C Worthy with Forms	295	269
Greenleaf Data Windows	295	249
Microsoft Windows Dev. Toolkit	500	365
Panel Plus by Roundhill	495	395
View Manager for C,Blaise	275	199
Vitamin C...*Creative Programming*	225	198
VC Screen...*Source code Generator*	150	119
Windows for C	195	149
Windows for Data	295	259
Zview....*Data Management Consultants*	245	122
C UTILITY LIBRARIES		
Basic C....*Basic-like routines for C*	175	139
Blaise C Tools Plus/5.0....*f/MsC & QuickC*	129	99
Blaise Turbo C Tools...*f/TurboC*	129	99

	LIST	US
C Food Smorgasbord by Lattice	150	109
C Utility Library by Essential,300 functions	185	119
Greenleaf Functions	185	139
PforCe by Phoenix, vast library	395	199
OTHER TOOLS		
BASTOC...*JMI,Translates BASIC to C*	495	399
dBX Translator......*dBASE to C translator*	550	469
with Library Source	950	829
Pre/C....*by Phoenix, like UNIX lint*	295	289
PC-LINT..*by Gimpel, subset of UNIX Lint*	139	125
COBOL		
Micro Focus COBOL/2	900	795
Micro Focus Toolset	900	795
Micro Focus Personal COBOL	149	134
Microsoft COBOL inc. COBOL Tools	700	499
for XENIX	995	749
RM/COBOL...*by Ryan McFarland*	950	697
RM/COBOL 85...*ANSI 85*	1250	895
COBOL Support		
Btrieve Softcraft's File Manager	245	179
GSS CGI....*Device independent graphics*	495	425
Halo.......*from Media Cybernetics*	325	249
RM/Screens..*Screen generator*	395	335
RM/Net+ 5...*R/M COBOL networking*	300	249
DBASE & RELATED PRODUCTS		
Applications Plus....*Fox & Geller*	299	249
Brief & dBrief..*Editor/Macro lang for DBase*	275	229
Clipper.....*Nantucket's DBase Compiler*	695	449
DATA-p..........*Wallsoft*	60	50
dBC III Plus supports multiuser commands	750	595
with Source code	1500	1195
dBC ISAM...*accesses dBase files*	250	175
with Source code	500	349
dBX Translator......*dBASE to C translator*	550	469
with Library Source	950	829
dFlow.......*Wallsoft*	149	124
Documenter.......*Wallsoft*	295	244
FoxBase+.....*Fox Software*	395	247
Multiuser version	595	397
QuickCode Plus........*Fox & Geller*	295	170
QuickEntry...........*Fox & Geller*	99	59
QuickReport...........*Fox & Geller*	295	170
UI Programmer....*Wallsoft*	NEW	CALL
FORTRAN Compilers & Utilities		
Btrieve: Softcraft's File Manager	245	179
GSS Graphics Development Toolkit....*CGI*	495	425
GSS GKS...*Kernel Sys,ANSI Level 2b*	495	425
Halo '88......*from Media Cybernetics*	325	249
Microsoft Fortran..*Ver 4.0,inc. Codeview*	450	295
for XENIX	695	499
R/M Fortran...*ANSI 77 by Ryan McFarland*	595	499
for XENIX	750	599
Spindrift Library....*By Spindrift Labs*	149	129
PROLOG		
APT..*PROLOG Tutor*	65	59
Arity PROLOG Compiler & Interpreter	650	569
Arity PROLOG Interpreter	295	239
Arity Standard PROLOG	95	77
PROLOG-86 Plus.........*Solution Systems*	250	199
Turbo PROLOG...*Borland Intl.*	100	75
Turbo PROLOG Toolbox...*Borland*	100	75
TEXT EDITORS		
Brief......*from Solution Systems*	195	155
dBrief..*Macro lang for Brief & DBase*	95	79

	LIST	US
Brief & dBrief Combo	275	229
Condor Editor....*Condor Corp SUPER SALE*	130	65
Epsilon.....*Lugaru*	195	149
KEDIT.....*Mansfield..identical to XEDIT*	125	99
KEDIT Ver. 4.0	150	128
Pmate.....*Phoenix*	195	179
Vedit Plus.........*Compuview*	185	129
DEBUGGERS		
Advanced Trace 86.....*Morgan*	175	119
C-Sprite...*Source debugger for Lattice C*	175	139
Periscope I...*Board, Switch, Software*	795	749
Periscope II..*Breakout Switch & Software*	175	139
Periscope II.....*Software only*	145	105
Periscope III....*8 Mhz*	1095	875
Periscope III...*10 Mhz*	1395	1129
Pfix 86 Plus....*Phoenix symbolic debugger*	395	199
LOGITECH		
MODULA-2 Compiler Package	99	79
MODULA-2 Development Pkg	249	199
MODULA-2 Toolkit	169	139
MODULA-2 ROM Package	299	239
MODULA-2 Window Package	49	39
PHOENIX		
Pasm 86......*Macro ASSEMBLER*	195	179
Pdisk......*Disk Management Utility*	145	134
PFantasy.....*six-pack take-away*	995	799
PFinish......*Profiler*	395	199
PFix 86 Plus.Symbolic Debugger	395	199
PForCe.......*Utility library*	395	199
PforCe...*Pforce for C*	395	199
PLink 86+...*sophisticated overlay linker*	495	269
PMaker.......*make utility*	125	109
Pmate........*Text Editor*	195	179
Pre-C........*Super-set of UNIX Lint*	295	289
Ptel.........*Binary Transfer Program*	49	39
POLYTRON		
PolyBoost....*Software accelerator*	80	73
PolyDesk III..*3rd Generation Desktop org*	99	73
PolyLibrarian...*Library Manager*	99	89
PolyLibrarian II	149	129
PolyMake.....*Complete MAKE Utility*	149	129
PolyShell.....*UNIX-like Command Shell*	149	109
PolyXREF2...*Cross Reference Util all lang*	219	189
PolyXREF2...*Single Language support*	129	118
PVCS Corporate...*Source Code Control*	395	329
PVCS Personal...*Personalised ver of above*	149	129
PVCS Network...*Powerful Ver. of PVCS*	Call	Call
RYAN McFARLAND		
RM/COBOL.....*ANSI 74 Standard*	950	697
for UNIX or XENIX	1250	999
RM/COBOL 85.....*ANSI 85 Standard*	1250	895
RM/FORTRAN.....*ANSI 77 Standard*	595	297
for UNIX or XENIX	750	599
RM/NET+5...*COBOL Networking*	300	249
RM/Screens.....*COBOL 85 Screen generator*	395	335
SOFTCRAFT		
Btrieve Softcraft's File Manager	245	179
Xtrieve...*Query language for Btrieve*	245	220
Report Option for Xtrieve	145	128
Btrieve/N File Management for Networks	595	449
Xtrieve/N.....*Multi-User Query*	595	459
Report Option/N...*Multi-user Rep Opt*	345	269
XQL......*SQL for Btrieve*	795	595

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PROGRAMMING PRODUCTIVITY TOOLS

ESSENTIAL C UTILITY LIBRARY

400 Functions, 30¢ Each

You've probably seen the speed and power of Essential's C function library without knowing it. Software greats have been using it for some time to give today's top products pizazz and panache.

Now grown to 400 functions Essential produces pop-up menus, save and restore screens and windows to disk or memory in as little as 1/10th second, and the fastest video output available. Library has a complete set of 50 business graphics functions, 40 string handlers, 28 functions for printers, 18 for mice, 11 for time and date. DOS interfacing functions offer disk error trapping, directory and file management. Everything in source, including sample programs that demo library functions. We have versions with pre-built libraries for all well-known C compilers, and a source code librarian is supplied for rolling your own.

	List:	PC Express
C Utility Library	**$185**	**$119**
Essential Graphics	**$299**	**$225**
Essential Communications	**$185**	**$125**
with Breakout Debugger	**$310**	**$239**

C-TREE & R-TREE

B-Tree File Manager Now Has Report Generator

c-tree: The only major b-tree file manager with network support in the standard low-cost version. c-tree™ gives you record-locking routines for DOS 3.1/3.2, UNIX and XENIX, and it even comes in C source code, yet there are no royalties. Source sticks to K&R, so c-tree is portable. Tests in many environments prove it.

Permits any number of keys for a data file—alpha, numeric, even floating point. Handles files with varied record lengths, multiple keys in one index file. Both high level and decomposed functions. It's the works.

r-tree: Adds the ability to produce ad hoc reports from files maintained by c-tree (v. 4.1 and up). Link a file description to the r-tree™ library, and use any text editor to write report scripts with no further C coding. Reports can access data in several files, select on criteria, join findings into new logical records, sort them, calculate new fields and columns, tabulate by control breaks. Comes in source, same portability as c-tree, and fits any compiler.

	List:	Ours:	Combined:
c-tree:	**$395**	**$299**	**$499**
r-tree:	**$295**	**$235**	

WINDOWS for DATA

M'soft Windows Compatible

"Onlt one package can be easily recommended" said *Computer Language* (June '87) reviewing nine window and data entry products for C. Complete field level functions specify prompt string, field length, data type, screen location, picture, target variable, entry rules, help messages, even functions to call for validation once data keyed in.

Windows for C is a subset. No data entry but all windowing functions. Unlimited windows can be made either to pop up or permanently overwrite the screen, scroll and highlight lists vertically and horizontally. Specify Compiler. Windows for Data: List **$295**, Ours **$259**. Windows for C: List **$195**, Ours **$149**.

BLAISE C TOOLS PLUS/5.0

C TOOLS PLUS/5.0 from Blaise Computing Inc. helps you to quickly build professional applications using the full power of Microsoft C 5.0 and QuickC. Now you can concentrate on program creativity by having full control over DOS, menus, interrupt service routines, memory resident programs, fast direct video access; windows; printer and keyboard control, and more!

Blaise Computing's attention to detail, like the use of full function prototyping, cleanly organized header files, and a comprehensive, fully-indexed manual, makes C TOOLS PLUS/5.0 the choice for experienced developers as well as newcomers to C.

C TOOLS PLUS/5.0 prebuilt libraries are ready to use with either QuickC or the Microsoft C 5.0 command line environment. Complete documented source code is included so that you can study and adapt it to your specific needs.

	List:	PC Express:
C TOOLS PLUS/5.0	**$129**	**$ 99**
Turbo C TOOLS	**$129**	**$ 99**
C ASYNCH MANAGER	**$175**	**$135**
Turbo POWER TOOLS	**$ 99**	**$ 75**
Turbo ASYNCH PLUS	**$ 99**	**$ 75**

PANEL PLUS

Library Source Code Gives It Complete Portability

There are no end of tools for screen design and data entry, but none quite like Panel Plus. Design a screen under program control, use Panel's utility to "run" and test it field by field, then pass it to Panel's code generator which delivers C source code. Options style the code to your compiler's liking, and you can of course do what you like to the source afterward. The code calls Panel Plus's function library, but now *the library comes in source*, so everything produced is highly portable. Not like other screen managers delivered as object libraries and which leave *you* to write the detailed code.

Panel Plus will operate in graphics mode via interfaces to graphics products it supports and can utilize the EGA's 43-line screen. Low-level I/O functions adapt it to various keyboards, screens, operating systems.

Panel's newest incarnation has every imaginable feature. A single screen design can have 1000 fields stacked as visual overlays up to 127 levels deep or as pop-ups. Groups of logical fields can be moved between levels. Screens can be output as compilable code or stored on disk for loading at run-time. Each field can be boxed, colored, multi-row, word-wrapped, and scrolled horizontally and vertically if larger than its on-screen view aperture. It can be assigned its own help and error message, can be told to accept certain characters, or to match a picture, and to check data after entry—proper dates, number ranges, etc.—using Panel's or your own validation routines. You can add your routines to Panel's test utility because even it comes as source. Fields are accessed in any order and control reverts to your application program after each field for choice of action.

For past Panelists, the new version has smaller and faster field and screen functions, tighter granularity, and an enhanced, reworked library. Major tool for the serious developer. List: **$495**, PC Express: **$395**.

POLYTRON VERSION CONTROL

Source Code Control for Any Language

PVCS allows programmers, project managers, librarians and system administrators to control the proliferation of revisions and versions of source code in software systems. Independent programmers, the leading software publishers and LAN companies, and hundreds of Fortune 1000 companies rely on PVCS to store and retrieve multiple revisions of text. It maintains a complete history of revisions as an "audit trail", generates status reports, and uses intelligent "difference detection" to minimize disk space for each new version.

On Corporate and Network PVCS simultaneous changes to a module are merged into a single new version. If changes conflict, the user is notified.

The "Logfiles" used to track changes are interchangeable between any PVCS product.

Corporate PVCS is for multiple programmers. It includes "branching" to maintain code when programs evolve on multiple paths. Personal PVCS offers most of the power and flexibility of corporate PVCS, but excludes multiple programmer features. Network PVCS is the Corporate version for LANs. File locking and security levels can be tailored to each project.

Ask for:	List	PC Brand:
Personal PVCS	**$149**	**$129**
Corporate PVCS	**$395**	**$329**
Network PVCS	**Call**	**Call**
PolyMake	**$149**	**$129**

dBC *Identical dBASE III Plus Files Using C*

dBC™ is a series of C libraries from Lattice which creates, accesses and updates files identical to those of dBASE itself. So dBASE can read and update the files too.

What for? It means both C and dBASE applications can operate on the same data bases interchangably. It means C programmers can interface with the big market of dBASE users out there, yet side-step the dBASE language. It means dBASE applications can now be linked to the universe of C libraries and tools to add windows, graphics, statistical analysis, all the things dBASE cannot do. It means the speed and power of C to impress clients accustomed to dBASE!

dBC's functions parallel all dBASE's file handling commands, many decomposed to permit direct data manipulation. Our versions of dBC mimic file formats for dBASE II and III and now dBASE III Plus makes your programs network ready!... as many stations as a network allows. Hands-off mode handles record and file locking and unlocking automatically. Close in functions give you direct lock/unlock control.

Supports all four memory models. dBASE II, III...List: **$250**, Ours: **$175**. dBASE III Plus...List: **$750**, Ours: **$595**. Call for Source Code Pricing.

Payment: We honor MasterCard, Visa, American Express (no surcharge), checks in advance, or funds wired to PC Express, c/o Chemical Bank, 126 East 86 St., New York, Account 034-016058. COD (U.S. only) for cash, money order, certified check (no fee). NY State, add sales tax. Purchase orders accepted from larger corporations and institutions at our discretion if you agree to net 30 days plus 2% a month late penalty thereafter.
Shipping & Handling: U.S.: UPS Surface: 1st product $6, each add'l $3. UPS 2nd Day Air: 1st product $12, each add'l $6. UPS Next Day Air and Federal Express shipment costs based on weight. International: Charges vary by destination and carrier. $10 per shipping container for export forms. Air parcel post at your risk beyond collected insurable amount.

C-WORTHY INTERFACE LIBRARY

The C-Worthy™ Interface Library wraps an entire user interface around your application. Its full power can be summoned by only a few high level calls. Sound exaggerated? A single function call can set up a complete text editor in a screen window. Recently acquired by Solution System, over 600 pages of Documentation, Turbo and Quick C version and a complete Interface Library have been added.

- High level calls pop menus and scrollable choice lists to the screen, restoring the background when dismissed.
- Windowing facilities open portholes of up to screen size for viewing virtual screens larger than the physical screen.
- Full context-sensitive help screen management takes over these chores and error messages. Automatic routines interrupt with pageable text windows explaining what to do next.

Novell found it "played a key role and accelerated development" in making its NetWare™ utilities easier for users. Ingenious demo: call for it.

Ask for:	List:	PC Express:
C-Worthy	**$195**	**$159**
with Forms Library	**$295**	**$269**

THE SPINDRIFT LIBRARY

Fully Functional Fortran Library.

Spindrift's smooth package offers something previously unavailable to the Fortran buffs...a basket of functions, packed to the brim. No more tedious coding. Just call on Spindrift with it's armoury of functions.

Any number of Windows may be defined, each with a striking border and brilliant color. Define "pop-up" screens, Save/Restore images, set Cursor shape. Snare an entire screen into a Character array.

The Keyboard; read it without echo, or sense any keypress during execution. Cursor controlled directly with Edit keys.

DOS interface includes: Call System, Call Exec, Findfrst/Findnext for (*) and (?) file searching. Search the Path, subdirectory and file manipulation, command line argument parsing, date/time functions, DOS environment access, and much more. Other utilities also included.

Specify compiler, Microsoft or Ryan McFarland. List: **$149.00**. Us: **$129.00**

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PC EXCHANGE PROGRAMMER'S WORKBENCH

dBASE AT THE SPEED OF C

dBx Translates dBASE Applications to C

You dBASE™ programmers know what an expressive and readable language dBASE is. It's a very comfortable development environment. But the price is debased performance. Even compiled dBASE doesn't offer the speed that some users require these days. The kind of speed offered by software written in the C language. The answer is dBx™.

dBx translates dBASE to C. It offers you a major competitive advantage over the next dBASE programmer: Keep writing in dBASE. Take every application all the way to completion. Then use dBx to translate them top to bottom to C!

Other advantages: C is portable, even to other operating systems like UNIX/Xenix™. To the Macintosh or Amiga. dBx gives your applications a passport to places dBASE cannot go.

Has its own file manager for single user, but links to major C file managers—c-tree and dBC—for compatibility with dBASE files or multi-user support. We have everything you'll need, including good advice.

	List:	Ours:
dBx	**$550**	**$469**
with Library Source	**$950**	**$829**
Call for Full Source Pricing		

BRIEF/dBRIEF

The Power Environment for dBASE Programming

Many worthy utility products supply needs that dBASE®'s programming language doesn't—dUTIL™, dFLOW™ and a host of others. Trouble is, you have to use them separately, then combine their output into your dBASE program files.

No longer. dBRIEF™, written in BRIEF's macro language, grabs hold of BRIEF and turns it into a complete dBASE III and III Plus programming domain. Using BRIEF's underlying shell capabilities and its own interfaces, dBRIEF can run external utility libraries, plus dBASE itself, and link to the Clipper™, Foxbase+™ and Quicksilver compilers, all with dBRIEF still loaded and running the show. It can do what BRIEF already does plus:

- Convert a screen layout into dBASE code for interactive data entry.
- Display dBASE file structures in windows, a great convenience alongside your program files.
- Expand keystrokes into full dBASE statements.
- Indent automatically for clegic display.
- Create databases; index files; invoke Ashton-Tate's dFORMAT™ and dCONVERT™; draw lines and boxes.

"Simply marvelous programming environment for writing and editing dBASE programs.", *PC Magazine*, 7/86. Source code included!

Requires BRIEF 1.32 or later and 384k; 512k to run dBASE within dBRIEF; 640k and harddisk recommended.

BRIEF/dBRIEF...List **$275**, Ours: **call**

FOXBASE +2.10

The Fastest, Most Powerful, dBASE Compatible Database Management System, NOW!

New, **FOXBASE +2.10** is faster, and more powerful than dBASE IV...and it's available NOW! FOXBASE +2.0 is already a PC Magazine Editor's Choice...and has received an unbelievable 9.2 rating from Infoworld. FOXBASE +2.1 has new features such as built-in support for pull-down and pop-up menus, a new screen painter to create custom input screens, a new advanced automatic applications generator to write programs for you automatically, a new user interface designed to allow both first-time and experienced users to handle most database options effortlessly...and, much, much more... plus, Foxbase is still dBASE compatible and contains hundreds of dBASE enhancements. Run almost any dBASE program without modification. Foxbase fully supports commands like Browse, Edit, Append, Create, Modify, Report, and Modify Label, even in the middle of a compiled program! Foxbase supports EMS memory and local area networks.

	List:	Ours:
FoxBase +Version 2.10	**$395**	**$247**
Unlimited Runtime	**$500**	**$333**
FoxBase +Multi-User (LAN)	**$595**	**$397**
Unlimited Runtime	**$700**	**$467**
FoxBase +/386	**$595**	**$397**
Unlimited Runtime	**$500**	**$333**
FoxBase +Macintosh	**$395**	**$263**
Unlimited Runtime	**$300**	**$201**

MICROSOFT LANGUAGES

Powerful Implementations Of The Most Popular Programming Languages

Microsoft C 5.0: The flagship of the Microsoft line runs up to 30 percent faster than its predecessor. Its new optimization features deliver untouchable execution speeds, 100 new additional library routines...

Microsoft MacroASSEMBLER 5.0: If you ever wanted to take on the challenge of assembly, here's your opportunity. "MASM" 5.0 is a lot easier to use, has completely revised documentation, and a new "Mixed Language" programming guide that gives you step by step instructions for linking your assembly code with other Microsoft languages.

Microsoft QuickBASIC 4.0: is a revolutionary concept in BASIC programming. It allows you to run, edit, debug, and run again. Our friends at Microsoft have eliminated the dreaded compile step. Whenever you edit your code QB4 automatically incorporates your changes, so that it can run a program of 150,000 lines in less than a minute.

Each member of this language family includes the renowned debugger CODEVIEW.

	List:	Ours:
Microsoft C	**$450**	**$295**
Microsoft Macro-ASSEMBLER	**$150**	**$109**
Microsoft QuickBASIC	**$ 99**	**$ 66**
Microsoft FORTRAN	**$450**	**$295**

NOVELL: BTRIEVE, XQL, XTRIEVE

Sophisticated Tools Essential For Fast Database Handling

Btrieve is a library of subroutines that allows the programmer to build a database application using any language. It takes complete charge of all file creation, indexing, reading, writing, insertion, deletion, forward and backward searching. Its balanced tree indexing scheme finds any key in a million in less than 4 accesses...That's fast!

Btrieve is multi-lingual also. It includes more than 20 language interfaces (including C, BASIC, PASCAL, FORTRAN). However if it turns out that you are using something a little unusual, worry not. The manual includes a chapter on how to write a language interface to Btrieve.

Btrieve's vital statistics are equally impressive. Files may have up to 24 indexes; fixed record length to 4090 characters; variable length to 64K; indexes to 255 characters; files of 4 billion bytes. Network support includes Novell, 3-COM, IBM PC NET, Software Link's Multilink and many others.

XQL is a relational database management system designed especially for programmers. Imagine being able to access your database with the ease of SQL (Structured Query Language) statements and still having the power to process that data right down to the byte level.

Think about your applications. A large part of your software development effort is probably devoted to managing data stored in files on disk. Hours spent writing lines of code to search and store data records could have been used to program more important parts of your application. Why not let XQL do it for you. XQL will increase your programming productivity and let you focus on building better applications.

The XQL system works in tandem with Btrieve and has an equally powerful chassis...No limit on the number of records per file. Max. file size is 4 gigabytes, Max. record size equals 4K, Max. indexes per file is 24. The one version works for single or multiuser systems, DOS Ver 3.0 or greater. All languages are supported.

Xtrieve is the final ingredient in the Novell programming recipe. It is a menu driven, data retrieval system, that allows you to quickly find information and display reports. System developers can easily customize Xtrieve to display command menus, help files, and error messages in the English spoken by the customer. Xtrieve screens then gives menu choices that users can quickly recognize, making Xtrieve an easy product to use and understand.

Report Option for printing customized reports, form letters, mailing labels & statements.

	List:	Ours:
Btrieve	**$245**	**$179**
Btrieve/N	**$595**	**$449**
XQL	**$795**	**$595**
Xtrieve	**$245**	**$220**
Xtrieve/N	**$595**	**$459**
Report Option	**$145**	**$128**
Report Option/N	**$345**	**$269**

GSS GRAPHICS SYSTEM

Leave the Device Driving to GSS

For serious applications stick to the tools that stick to the standards. Not the least of reasons why GSS™ has emerged as the pre-eminent graphics toolmaker is that it has always conformed to ANSI standards.

At the heart of the system is the CGI standard Development Toolkit. It has all language interfaces and device drivers for keyboards, mice, joysticks, tablets, printers, plotters, cameras. The drivers completely insulate your application from concern for device idiosyncracy.

GSS Kernel™ conforms to ANSI's GKS 2b and has all its drivers and language bindings. Macro level tools to draw, color, segment, transform, store and recreate an object. The Metafile Interpreter reads ANSI CGM files with full CGI capability for recreation on various devices.

Quality software? IBM thinks so. They sell GSS under their own label. Royalties. Needs 256k.

	List:	Ours:
CGI Dvlpment Toolkit	**$495**	**$375**
Kernel System	**$495**	**$375**
Kernel for IBM RT	**$795**	**$645**
Metafile Interpreter	**$295**	**$235**

CLIPPER $449

R&R RELATIONAL REPORT WRITER $129

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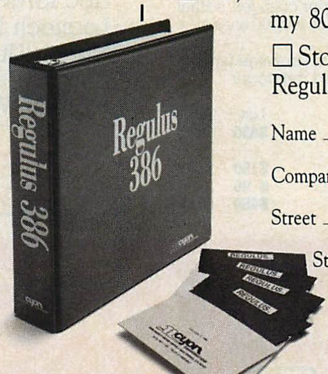

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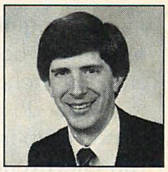


P.C. Coffee

In *Systemantics*, a brief but classic analysis of how people function, John Gall writes of a man in his neighborhood who is building a boat in his backyard. "He knows very little of boatbuilding," Gall observes, "and still less of sailing or navigation. He works from plans drawn up by himself. Nevertheless, he is demonstrably building a boat and can be called, in some real sense, a boatbuilder."

Contrast this, Gall suggests, with the operations of a "real" shipyard. "Look around for a shipbuilder," he challenges. "You will be disappointed. You will find welders, carpenters, foremen, engineers . . . the company executives may call themselves shipbuilders, but their work consists of writing contracts, planning budgets . . . In cold fact, a *system* is building ships, and the *system* is the shipbuilder."

In the same way, it wasn't long ago that one person could be a backyard, one-desk department of systems integration. The company-standard word processor isn't doing compressed print correctly? Call the local expert to learn about printer control codes. The spreadsheet is taking too long to enter data? No problem, the expert will explain how you can turn off automatic recalculation.

Today, however, the full spectrum of systems development and integration problems—not to mention support—has gone beyond the boundaries of individual competence. The multivendor environment and the proliferation of networks create a challenge that requires different skills, not just more of what you have had all along. You need to develop a broadly based system (of people as well as machines) that accepts today's new reality: beyond the backyard level, no one can know it all.

Systems built with backyard smarts will still work, but they will be rowboats in a world that demands America's Cup performance.

How bad can things get when the process gets too complicated for the system that controls it? A recent study identified three fundamental problems that arise when this happens: contradictory policies, flawed decisions, and unprofessional implementation.

You may recognize the source: these are three of the primary points from the report of the Tower Commission on the Iranian arms sales. It's amazing how much the report sounds like an analysis of any organization whose responsibilities have outgrown its knowledge and judgment.

CHECKMATE IN THREE

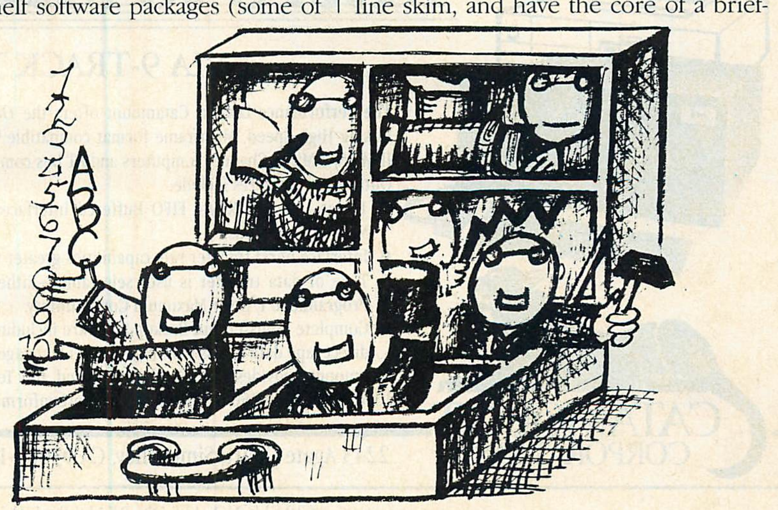
We can look at the practical consequences of the three problems outlined by the Tower Commission in terms of our most basic applications—word processing, spreadsheets, and databases.

Contradictory policies. Insisting on the kind of single-standard PC architecture that held sway just a few years ago is no longer easy. During the last year, I have talked to systems developers and integrators in health care, engineering, consumer products, and refining; all of them make essentially the same point. They are typically using two or more off-the-shelf software packages (some of them on very dissimilar machines) for any given application. Often, this is because the application has forked into two distinct approaches to meet two different sets of priorities.

In word processing, for example, there is a growing tension between desktop publishing and production typing. In many situations, documents need to go to the client, or they represent in-house communications that are important to the credibility of the group that produces them. Today's sophisticated page-layout tools, especially on the Macintosh, have a powerful allure for these people.

Management becomes justifiably concerned, however, when the higher overhead and lower text-manipulation performance of these packages create real and substantial costs in the production of routine correspondence.

Although they take more time and effort than drawing packages, today's most powerful word processors can produce beautiful word charts, even incorporating graphics. For those who take the time to figure it out, the rewards are many; for example, they can simply take the main document on which a briefing is based, extract key phrases and figures with a quick online skim, and have the core of a brief-



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ing that requires only reformatting and printing to be guaranteed consistent and comprehensive.

How do you resolve the conflict between up-front simplicity and long-run effectiveness? In today's overhead-conscious business climate, you cannot afford to provide enough hot-line support to make people prefer the less-obvious approach on technical merit alone. People don't work that way. If you give them one tool that they can use only with frequent help—no matter how readily that help is available—and another that they think they understand on their own, they will always choose the latter.

If a tool produces better results, but isn't readily approachable, then the best support is to eliminate problems in advance, rather than solving them as they arise. That means, in the case of word processing, finding out what people actually do with words in your organization. How many times is the typical draft revised, based on reviews by how many different people at once? Are red-lining and consolidation of revisions required, or are reviews done in sequence rather than parallel?

If you don't know the paths of information that form the documents your organization delivers, then your support for this critical application can be nothing more than reactive fire-fighting. The problems of contradictory policies arise when the effort thrown at the problem grows faster than the actual understanding of true needs. Under these conditions, you lapse into crisis mode, and you don't have to read the 550-page Tower Commission report to know what happens when crisis mode becomes routine.

Flawed decisions. The original vision of the PC-based spreadsheet was just an automatic version of a mundane analytic tool. It's amazing, and a little scary, that the concept has grown into the heart of the decision-making process in many organizations.

Beware, however, of the phenomenon that operations-research theorists call *suboptimization*—that is, making each piece of a solution as good as it can be, even if overall performance is thereby reduced. People frequently tweak an individual spreadsheet within an inch of its life to push some critical result over some critical threshold.

"Suppose we show the market share as 12 percent instead of 10 percent," a typical argument goes. "Does that put the return over the minimum?" Well, what if it does? Some would argue that estimated market share has at least that much room for error; why, then, do they feel that being one-tenth of a percent over some minimum is a comfortable margin?

When all tolerance bands are stretched in the same direction, the cumulative effect can be considerable. To address this problem requires rising above the issues of skills to tackle the issues of application. What, in fact, are the basic parameters (inflation, market growth, and required return on investment) that truly need to be consistent in critical analyses, all across your organization? Does a good mechanism exist for making consistent sets of values available to everyone who needs them? If you are using a spreadsheet that supports linkage, perhaps the standard values could be distributed in this form.

Another alternative would be the development of spreadsheet templates, properly documented, for standard analyses used as part of a company's regular cycles of operations and investment. Key parameter values would be included as named ranges, simplifying their use in formula cells, but at the same time you could include other neglected elements of good spreadsheet practice: cross-footing, provisions for estimating error, and so on.

As in document production, one consequence of more complex needs is the emergence of two-tier solutions. In the same way that word processing has matured into desktop publishing, spreadsheets are being supplanted by executive support systems—some of which apply expert-system techniques to management-decision support.

One of the axioms of successful expert-system development, however, is that the expert system must get used enough to pay back the cost of development. A relatively narrow and well-defined problem must arise fairly often to produce that payback. Ask yourself, sternly, if that criterion is met. If the answer seems to be yes, make sure that the definition of the problem is not so broadly drawn that it cannot be practically attacked using an expert-systems approach. Asking yourself these questions will help guard against flawed decision making.

Unprofessional implementation. The world is overflowing with examples of unprofessional implementation in the context of the third applications group: PC-based data management. Users and developers who do not really understand the relational model try to fit as much as possible into a single set of records. Rarely do users go looking for opportunities to maximize their ability to use the data in different ways, merely by organizing them properly from the start.

Data validation is often neglected in the PC environment. If you have rules for acceptable input, you should encode them as part of the input screen or as help text (if they are too verbose to fit in a corner). Actual input-checking code, character-by-character, or (at minimum) field-by-field, is part of doing the job correctly.

The alternative to improved applications development aids is the development of ever-friendlier tools for ad hoc queries. A few months ago, I encountered a developer who coded sensitive applications under a third-party dBASE compiler as a form of security, while making Paradox available to users as the standard for informal applications. The users liked Paradox and felt no incentive to learn the more traditional programming approach of dBASE. For these users, as well as many others, dBASE source code is effectively self-encrypting. This developer could therefore take advantage of both the performance of compiled code and the flexibility of more user-friendly systems—with good results.

Closely related to professional implementation in data management is file-system integrity. This issue of files is a time bomb waiting to explode. Memory and CPU problems of OS/2 distract people from the fact that OS/2 uses the same, vulnerable, single-user file system that we have had since DOS 2.0. Installable file systems that provide greater integrity are an eagerly awaited enhancement to OS/2.

Even if the files are intact, what good are they if you can't get to them? Network security, reliability, and performance are areas where the interdependence of PC and other computing and communications systems continues to increase.

Many organizations are turning to lower-cost network options such as twisted-pair Ethernet. In most cases, however, those spare twisted pairs in the walls and the wiring closets are under the supervision of a data communications or telephone-services group, which has had little contact, so far, with the PC development team. It's never too late to start meeting people who could be important to your future.

BUS WARS, EGO ISSUES

As users' needs become more complex, what used to be one application suddenly becomes a family of related tasks with differential specialization of tools. Support is strained to the breaking point. So far, I've been talking primarily about software, but the same phenomenon is happening in hardware.

The bus wars, for example, rage on. The Extended Industry-standard Architecture (EISA) competes, at least on paper, with IBM's Micro Channel. Some people continue to insist that an AT-class machine can handle any important task.

With the Micro Channel-based PS/2 series, IBM has reappraised the needs of increasingly interconnected desktops and has developed a bus design that addresses these needs in PC, mini, and possibly mainframe alike.

The PS/2, whose benefits look increasingly real in highly connected environments, tells small developers that the stakes are being raised. The architecture of the next few years will be at the departmental or corporate level. It's going to be a game for bigger and more sharply focused players. The minimum level of wizardry is rising.

Some of us will continue to be country doctors, being all things to users with relatively limited requirements; others will enjoy the opportunity to specialize—perhaps in communications coprocessors, in graphics interface design and implementation, or in systems and data security.

The point is that the choice is here to be made. Not to decide *is* to decide; the default position of preserving the status quo may not be a career-enhancing decision if your organization can make good use of tomorrow's genuinely new capabilities.

Peter C. Coffee is managing partner of SolveWare, a developer and business computing consultant, and is active in AI and distributed computing applications for aerospace and educational clients.

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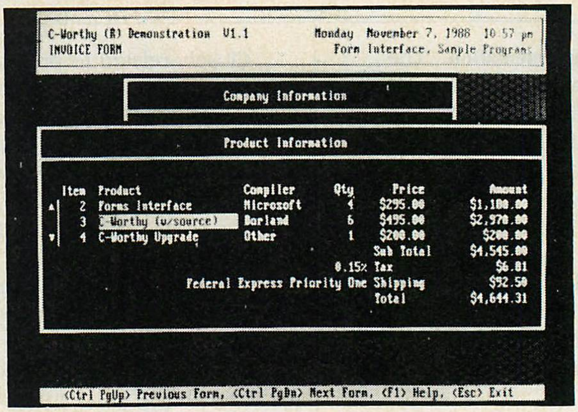

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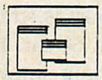

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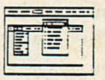

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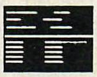

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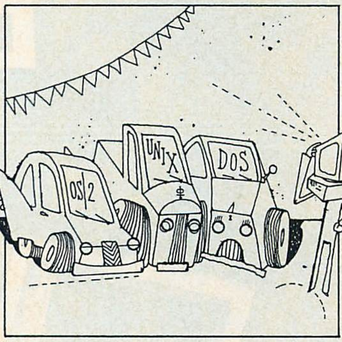


Many readers fuel their applications using DOS or Unix; others rely on multiple platforms to cover most miles.

Which PC operating system do you select for applications development? Respondents to a recent informal reader opinion poll say they favor three environments: DOS, Unix, or a combination of several platforms. OS/2 and other systems are counted on more as part of a group than individually.

Those choosing DOS alone stress user demand, cost, simplicity, application availability, hardware support, abundant tools, maturity, and opportunity for growth. Both large and small firms drive DOS.

"DOS has a large user base and is the Volkswagen Beetle of operating systems: small, ugly, affordable . . . and it works," says Craig Given, a programmer and consultant at Montague Independent Computer Consulting in Chattanooga, Tennessee.

Speaking for the developer on a strict budget, Paul Schlieve, coowner of Pro-Score in Denton, Texas, says, "It still costs thousands of dollars to move to OS/2 from DOS, and there are too many versions of Unix for a small developer to support."

Jerry Norton, a senior systems analyst at Reflectone Inc. in Tampa, Florida, believes, "DOS is safest for us over the next five to ten years. Any future mainstream operating system will support, run, or convert DOS programs."

Kevin Mackenzie, president of Voice Solutions Inc. in Portland, Oregon, has a long list of reasons for choosing Software Link's PC-MOS. Mackenzie states that PC-MOS is "compatible with most DOS software; is multitasking and multiuser; is able to use extended memory; is supported by a strong company; and has high-quality software, documentation, and good customer support."

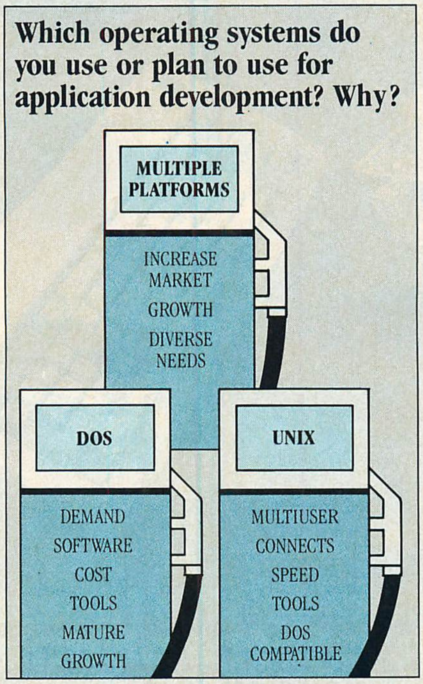
Likewise, Brian J. Mullan, a systems consultant at McDonnell Douglas in Tampa, Florida, chooses Concurrent DOS 386 because it is "multiuser and multitasking with support for most DOS applications, is realtime, supports interprocess communications via queues and semaphores, and is DOS 3.*x* LAN compatible."

UNIX ONLY

Respondents with Unix (including Xenix and QNX) are steered by a need for multiuser functionality; connectivity among PCs, minis, and mainframes; speed; powerful development tools; and DOS compatibility. They are frequently systems developers of large applications.

"Unix is a portable, flexible, secure, stable, expandable, multiuser, and widely accepted operating system," says Greg A. Woods, senior consultant at Elegant Communications Inc. in Toronto, Ontario, Canada.

"Although Unix has archaic commands, by using aliases and a powerful script and batch language, developers can customize the user interface. Add to that the flexibility of Unix multitasking and the diversity of the hardware supported (PC to Cray)—there can be no other choice," concludes Larry Widing, senior software engineer at Design Software in Chicago, Illinois.



THE MORE, THE BETTER

Those with diverse application needs usually harness two or more PC operating systems, including DOS, Unix, Novell's NetWare, OS/2, and the Apple Macintosh environment. The result is a larger customer base and more potential for growth, including extendibility beyond PCs.

"I prefer DOS-OS/2 over Unix because the OS/2 programming environment is more flexible," says Ray Horn Jr., chief executive officer of L^2 Software Company in Torrance, California.

"VMS, Unix, DOS, OS/2? Different hardware environments support different graphics, realtime, and multiuser environments; the hardware must be chosen to suit the application and the software, to drive the hardware," reasons Jeffrey Schutzman, a staff engineer with BBN Systems & Technologies in Cambridge, Massachusetts.

After an agonizing period of study, Frank Evans, a research engineer at Intelledex in Corvallis, Oregon, chose QNX "for realtime industrial control applications; Unix for robot system code and its future prospects; and DOS for its programmer tools and industry acceptance."

THE CLASSICS

While it is not difficult to understand the loyalty to DOS, the prevalence of Unix in the face of newer multitasking systems indicates a preference for classics. Although multiple platforms are not for all systems developers, they are often the choice of those who must satisfy a variety of users and application needs and who want the greatest possible flexibility.

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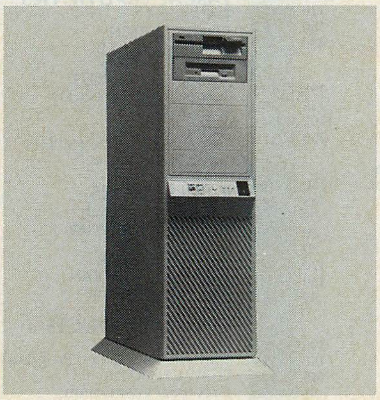

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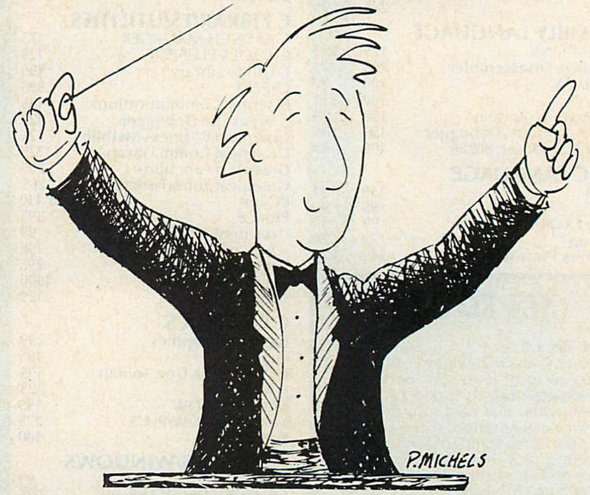

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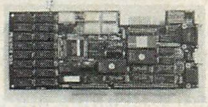
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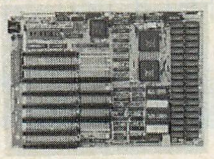
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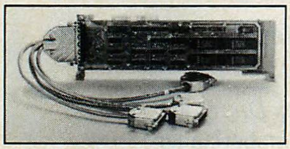

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3 Is your purchase involvement:
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- f ☐ Division-Wide
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- i ☐ 26-99
- j ☐ 100-499
- k ☐ 500-999
- l ☐ 1000 or More

5 Are PCs within your company used for:
- m ☐ Programming
- n ☐ Data Management
- o ☐ LANS
- p ☐ Host/Communications
- q ☐ Programming Languages/Tools

6 Are you planning to purchase in the next 6 months:
- r ☐ Programming Languages/Tools
- s ☐ Data Management Software
- t ☐ LANS
- u ☐ Host Communications
- v ☐ Operating Environments
- w ☐ Computer Systems

7 What is your primary job function? (Check one)
- x ☐ Systems Design/Integration/Analysis
- y ☐ Data Communications
- z ☐ Outside Consulting
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101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
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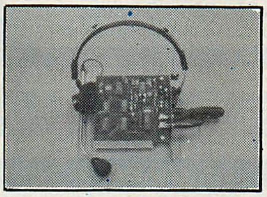

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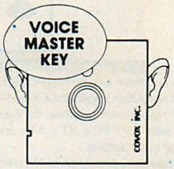

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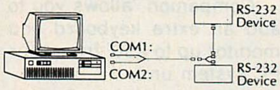

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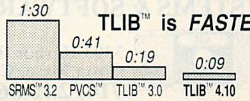

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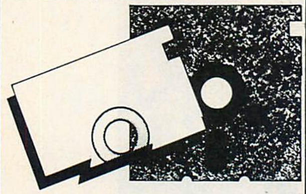

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TECH MARKETPLACE
The Comprehensive Buyer's Guide For Systems Developers And Integrators

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Prices and specifications are subject to change. Verify with manufacturer.

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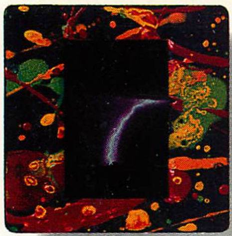

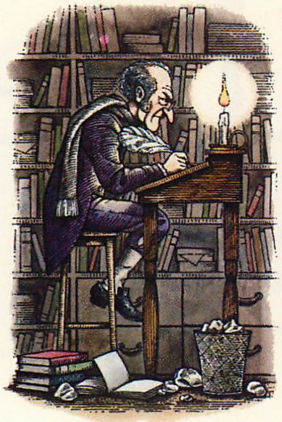

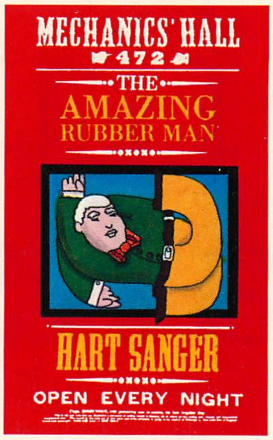

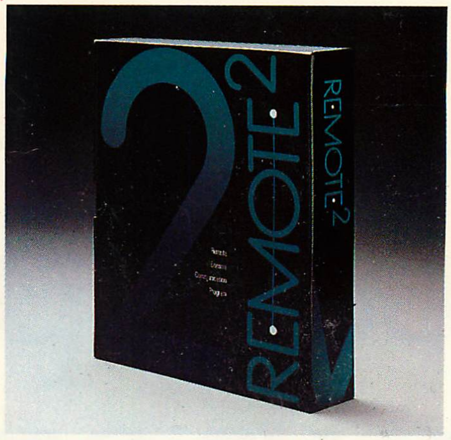

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